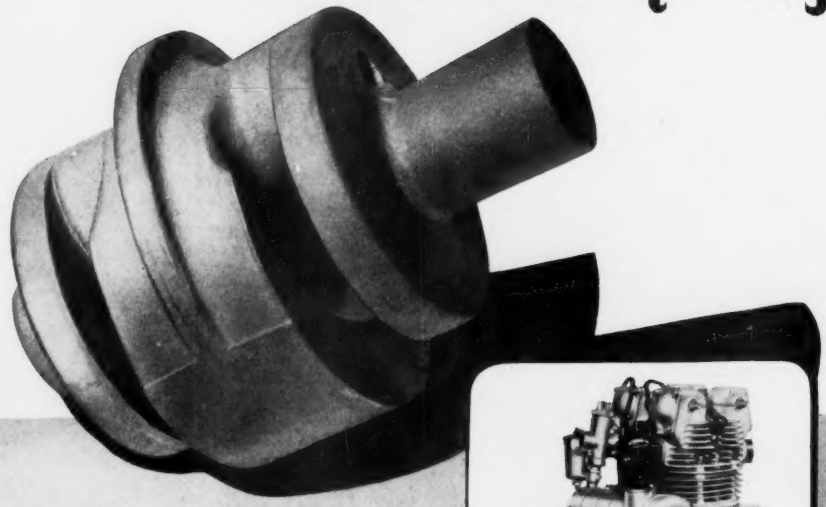
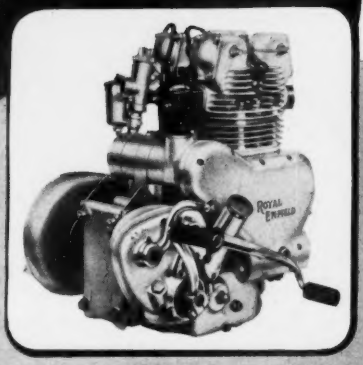
AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

Vol. 42 No. 555. JULY, 1952 PRICE : 3s. 6d.

Royal Enfield are making sure with HARPER quality





The engine of the Royal Enfield "500 Twin" motor-cycle in standard trim develops 25 B.H.P. at 5,750 R.P.M. and can reach 7,000 R.P.M. The crankshaft is a "Harper-Meehanite" casting. The Enfield Cycle Co. Ltd. say: "The excellent machining properties of the material, together with its mono-bloc construction, make this a much simpler production proposition than a built-up crankshaft, besides ensuring that it runs dead true at all times."

Harper quality covers grey iron and Meehanite castings, and also metal pressings, machining, enamelling and other finishes and sub-assembly work.

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1st in Class F were both fitted
with MINTEX BRAKE LINERS
(Results subject to official confirmation)
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you can rely on MINTEX
MINTEX BRAKE AND CLUTCH LINERS are manufactured by
BRITISH BELTING & ASBESTOS LTD., Cleckheaton, Yorkshire,
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Photograph by courtesy of Lancashire Dynamo & Crypto Mfg., Ltd., Manchester.

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If *you* want to get the best out of carbide tooling, ask for genuine Wimet and see that you get it — made only by Wickman of Coventry.

Publications dealing with all aspects of carbide tooling are available on request, and 'The Wimet Age,' a 16 mm. instructional film on the application of tungsten carbide tools is available for exhibition in Engineering Works, Technical Colleges, etc. Write to-day for details.

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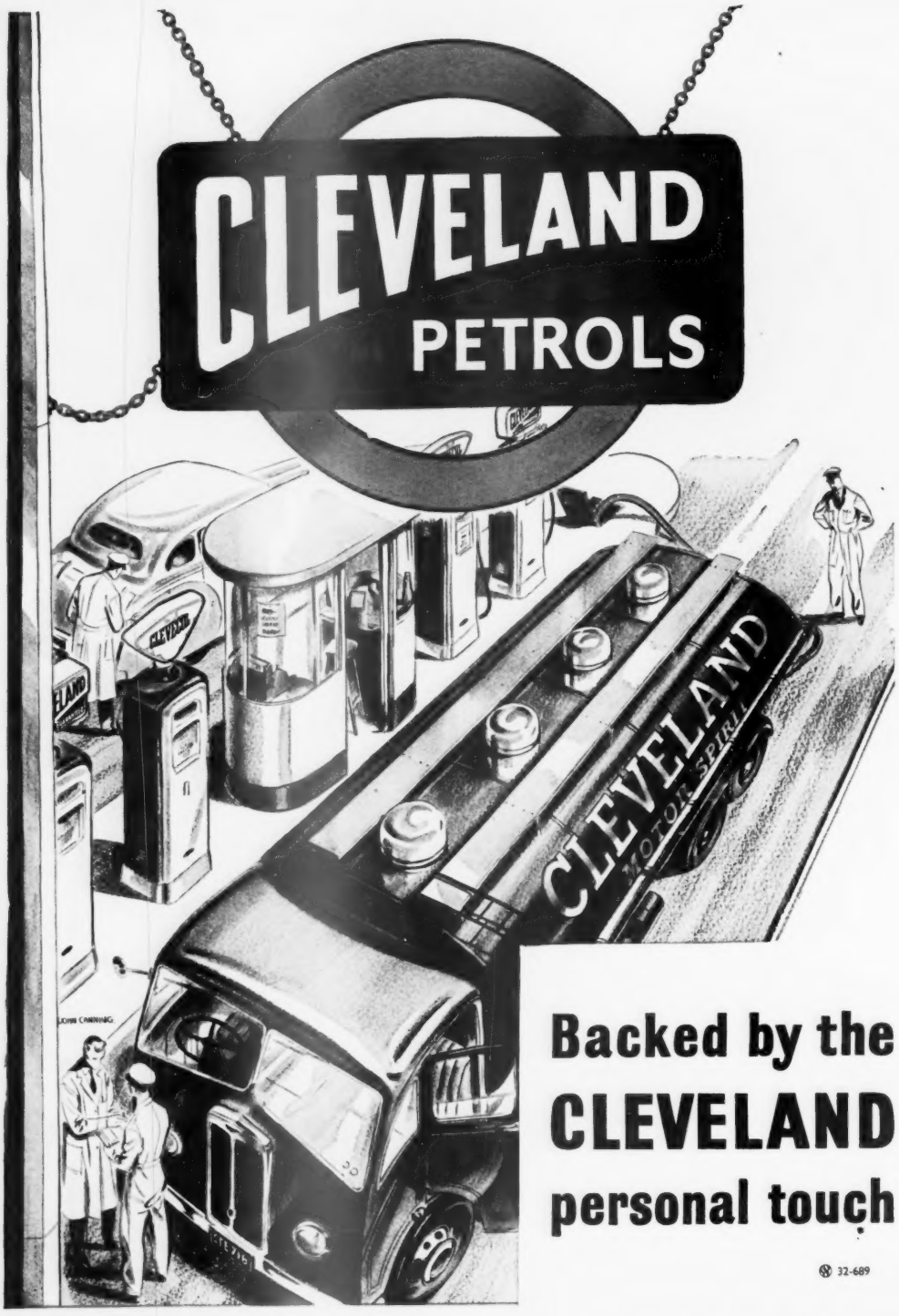

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Wickman for HELLER

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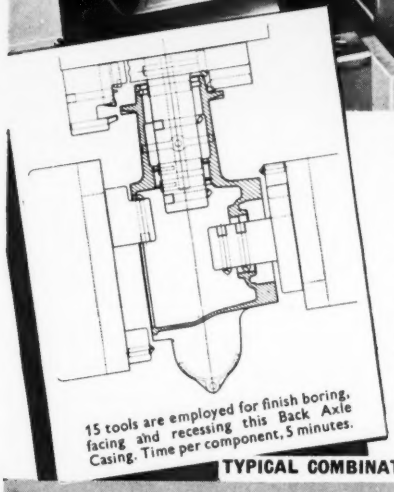

15 tools are employed for finish boring, facing and recessing this Back Axle Casing. Time per component, 5 minutes.

. . . unit-built around the component

Heller standardised boring head units can be built up into any required combination with interlocked controls to form complete and fully automatic mass-production flow-line installations. They are built in a range of sizes with spindle diameters from 50 mm. to 200 mm. and with maximum feed strokes from 200 mm. to 1250 mm.

The Heller hydraulic system enables feed stroke variations to be co-ordinated and hydraulic clamping of the component to be employed. Any number of units can be built into a single machine, interlocked and operated by a single control.

If you have parts requiring multiple boring and facing operations send component drawings to A. C. Wickman for examination. Wickman specialists will be glad to submit engineering proposals.

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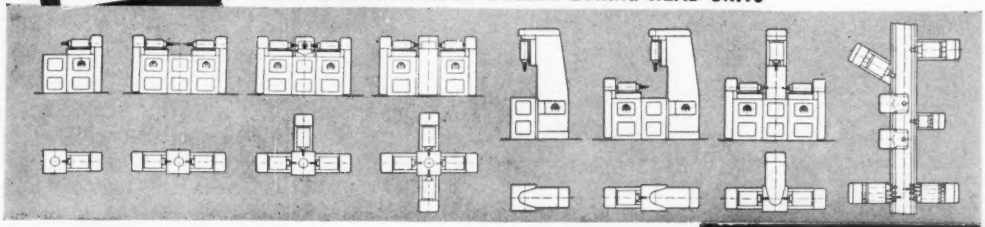

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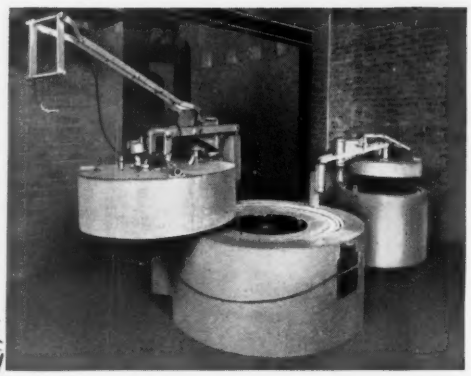
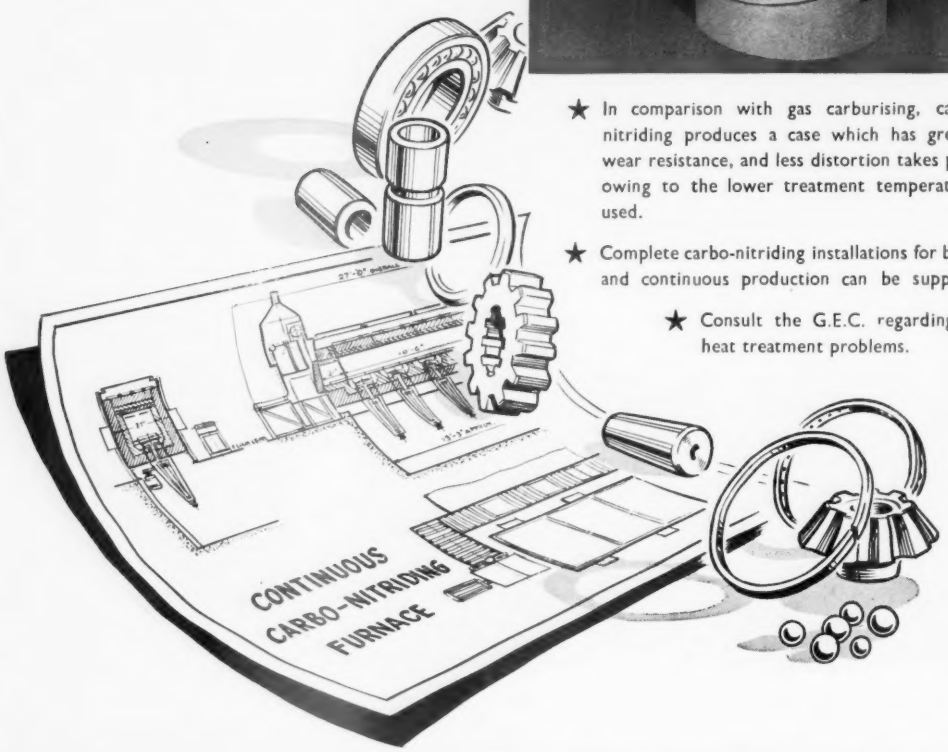
★ The process is cheaper than liquid cyaniding and the case composition as well as depth can be controlled. Cyanide waste is eliminated.



★ In comparison with gas carburising, carbo-nitriding produces a case which has greater wear resistance, and less distortion takes place owing to the lower treatment temperatures used.

★ Complete carbo-nitriding installations for batch and continuous production can be supplied.

★ Consult the G.E.C. regarding all heat treatment problems.



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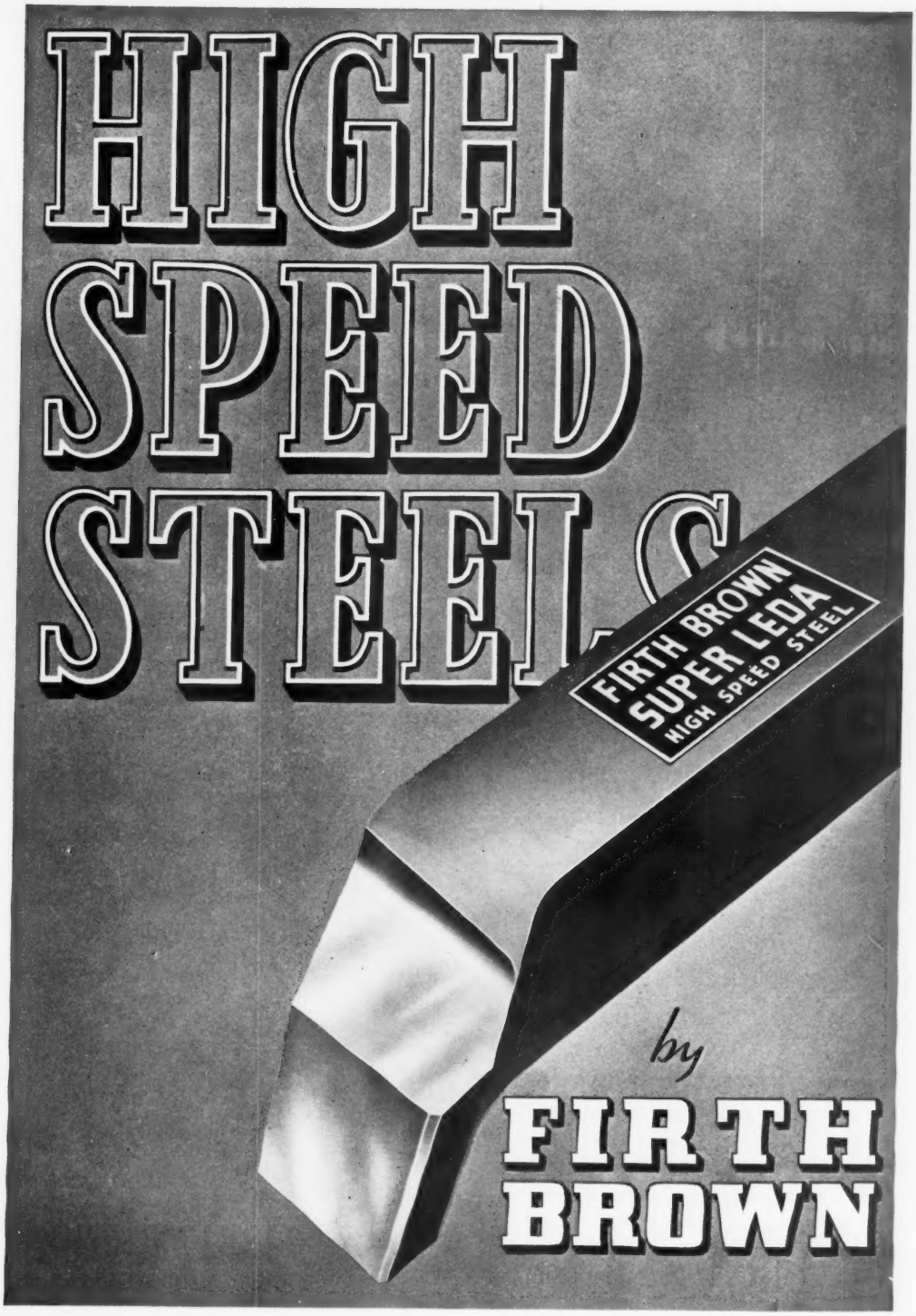

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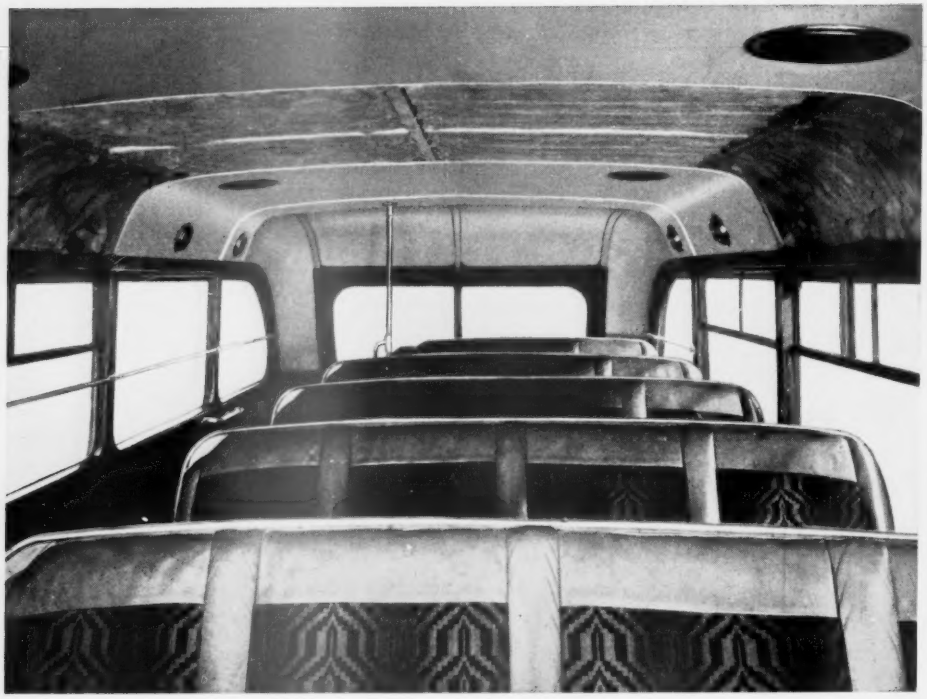

Photo: Courtesy of St. Helens Corporation Transport.

On hot days you'll find none of that supercharged omnibus atmosphere you often associate with public transport. On cold days you'll find it's warm inside. Even on horrid humid days no drops of moisture collect on the roof, to splash down the back of your neck. The reason for this improved state of affairs is the 'Fibreglass' insulation, which you see here revealed. 'Fibreglass', in such uses as this, prevents condensation and modifies extremes of temperature. What's more, it's easy to apply, entirely odourless, inexpensive and . . . ready for delivery!

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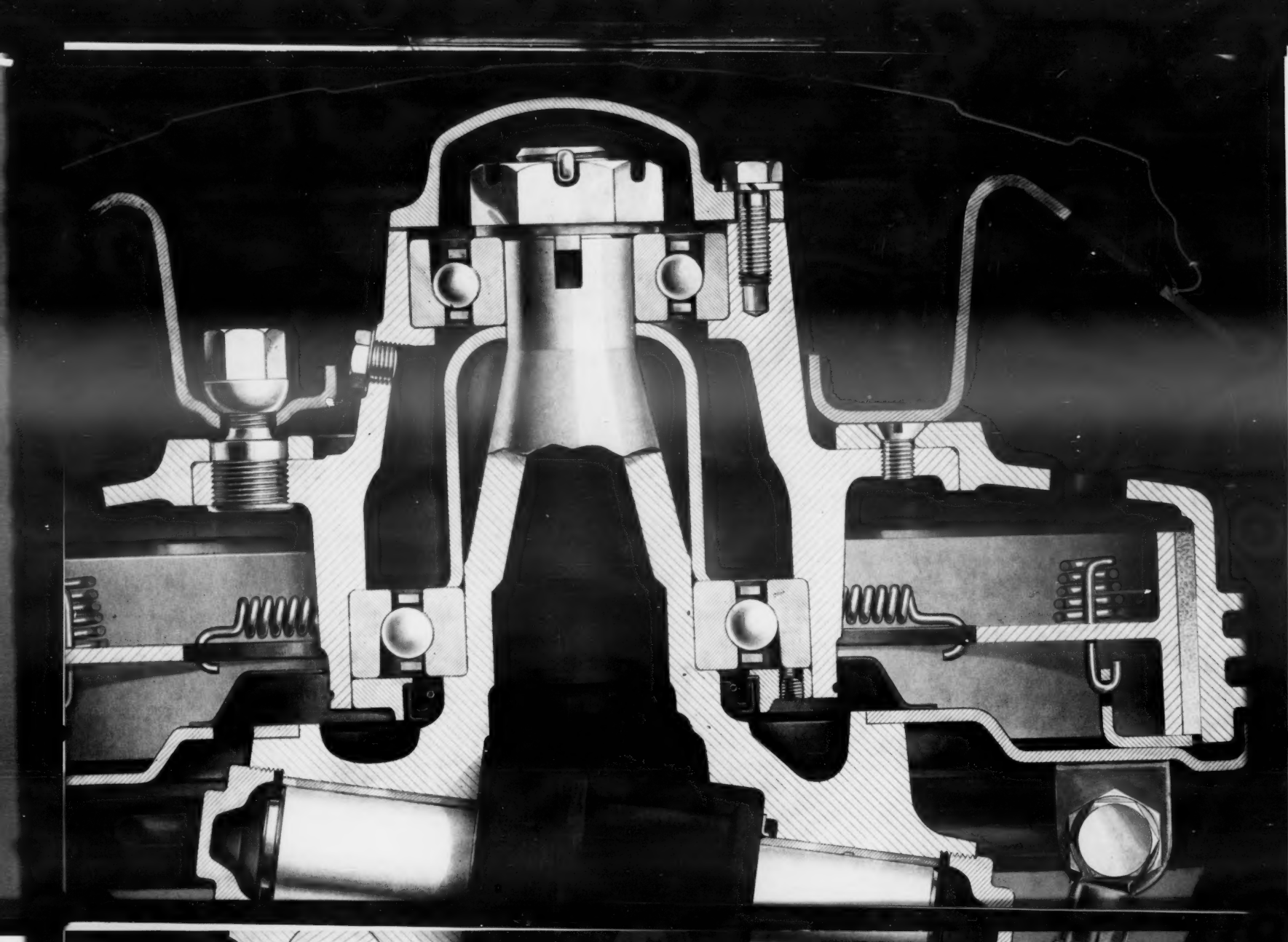

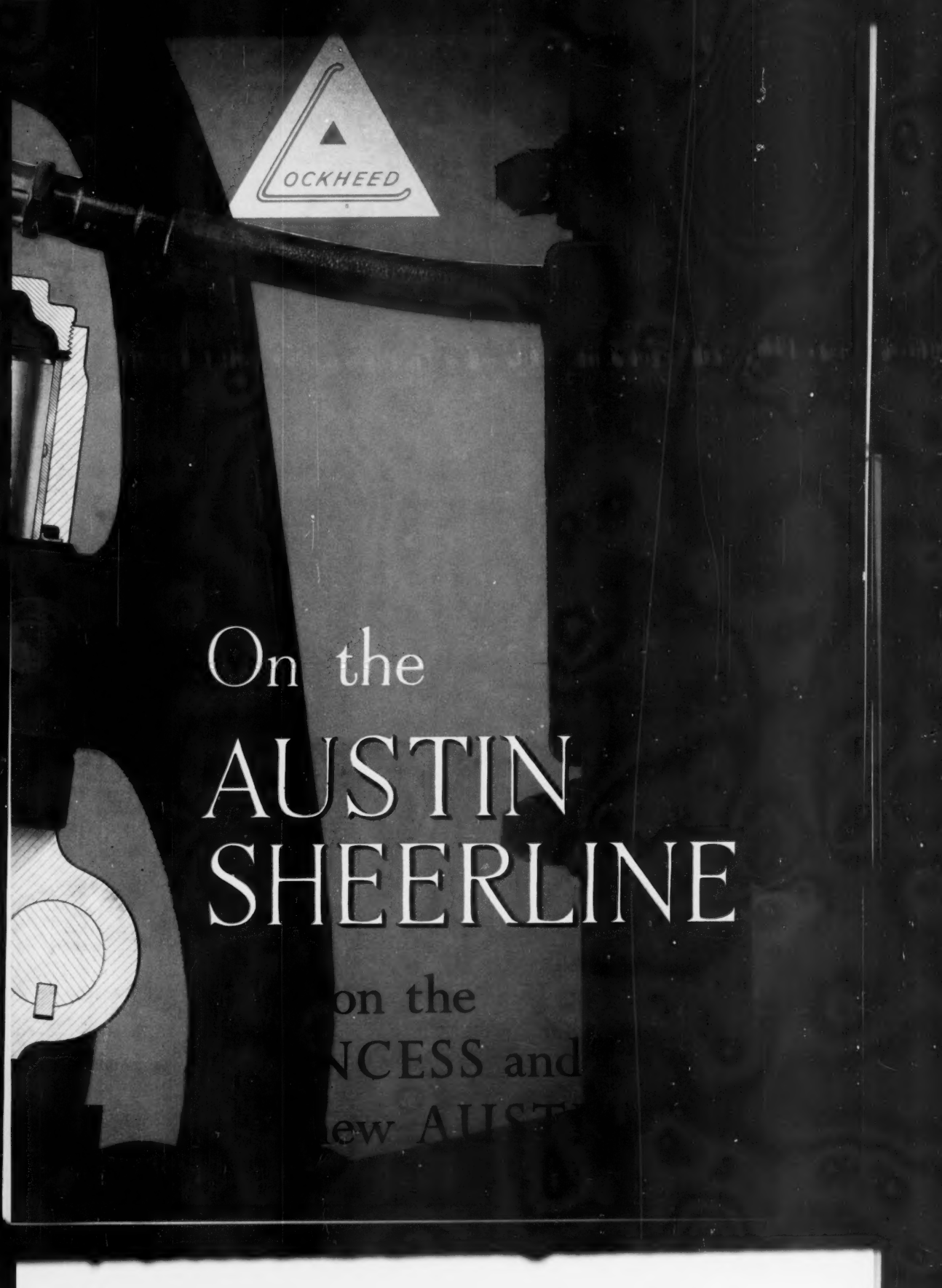
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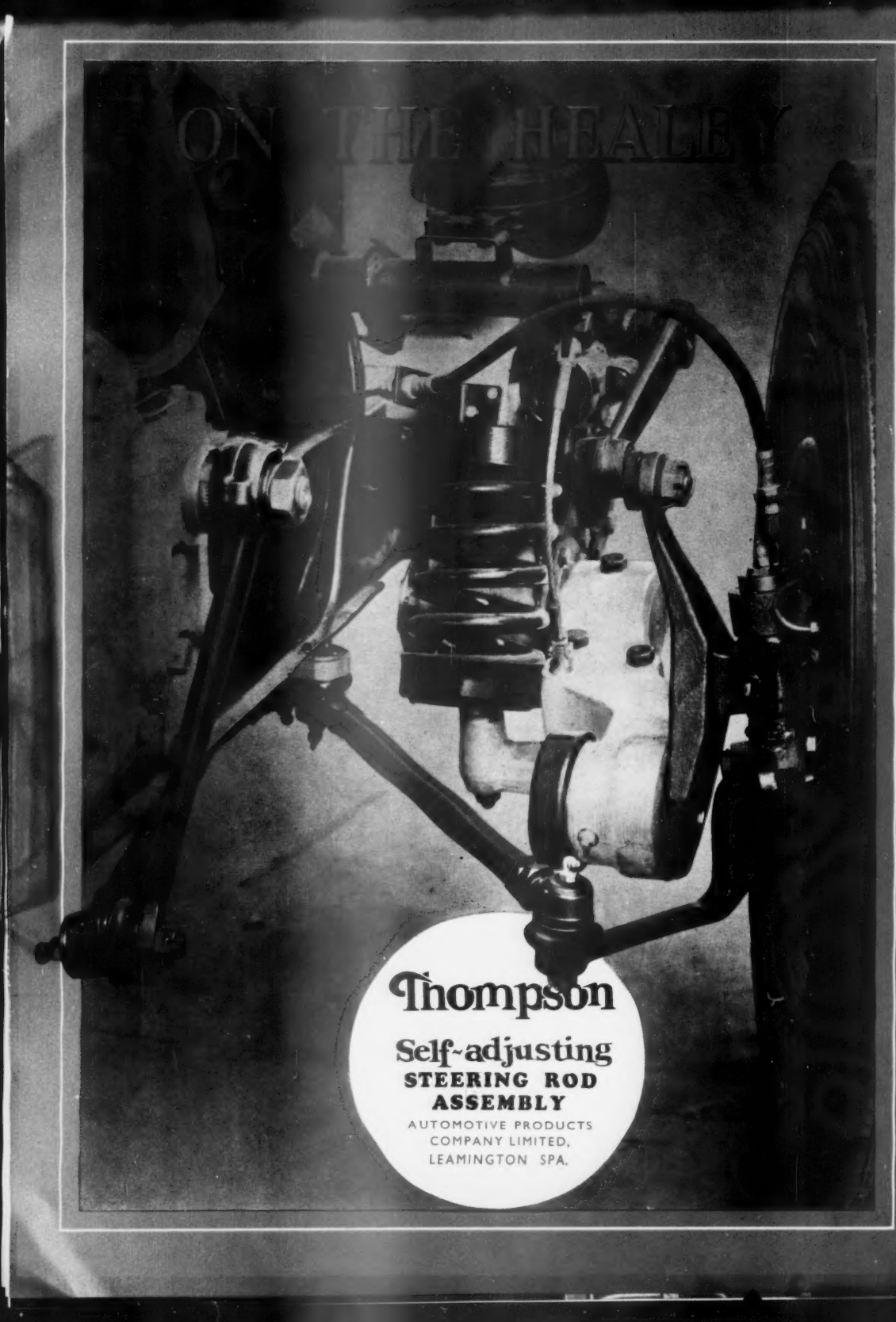
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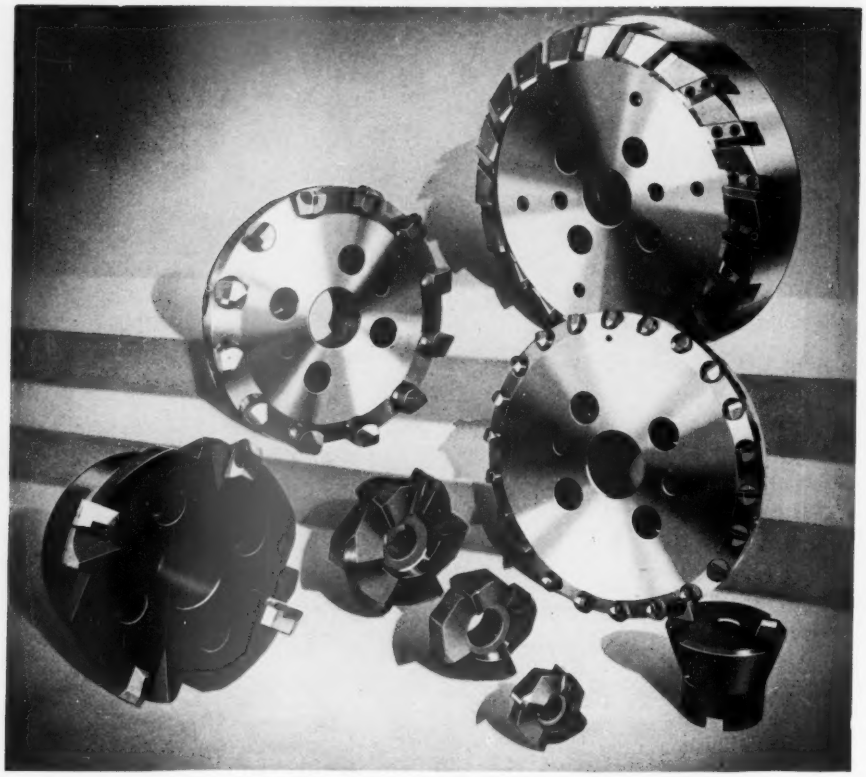

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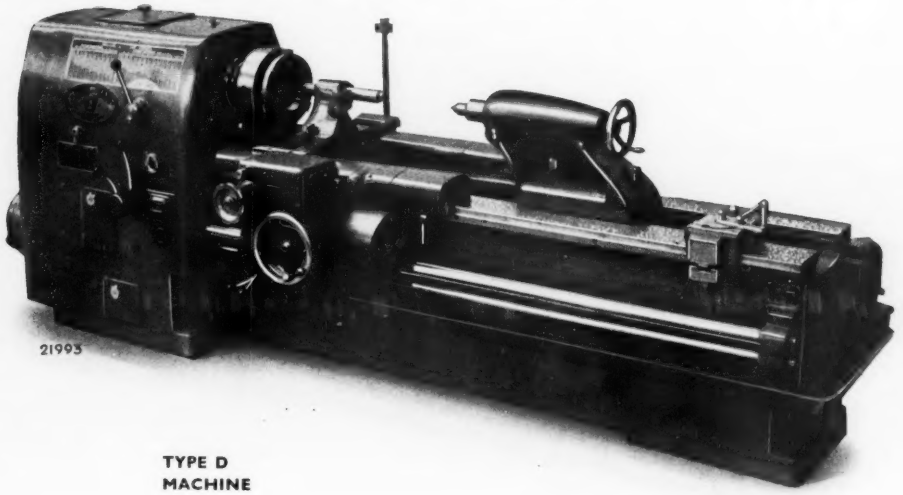

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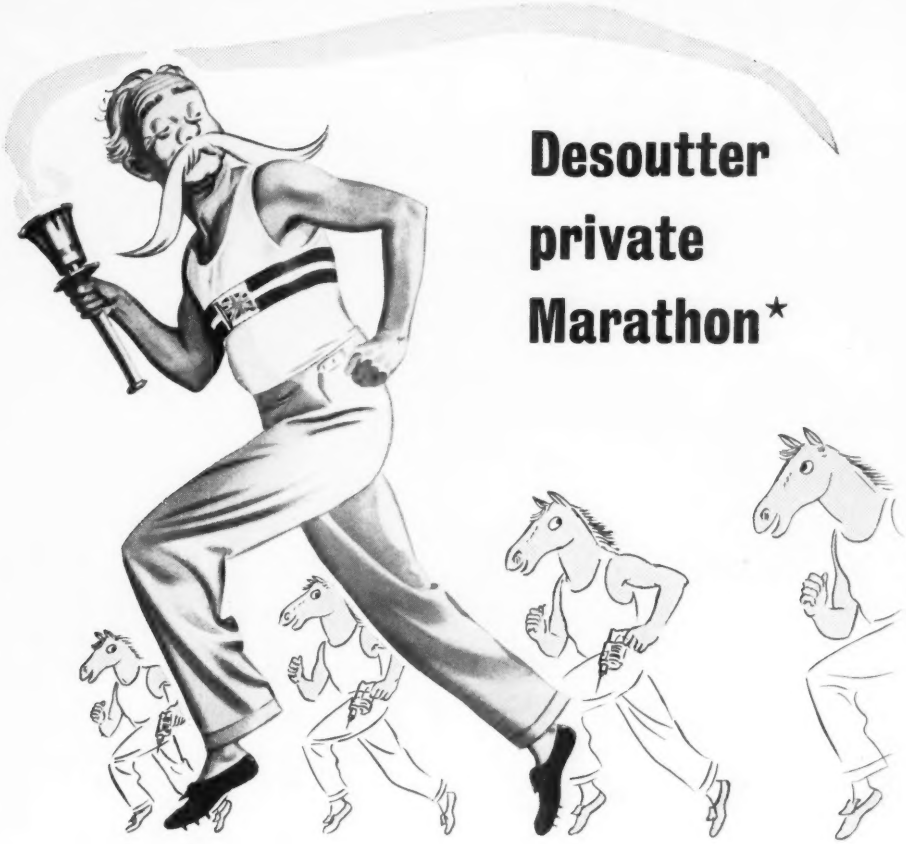

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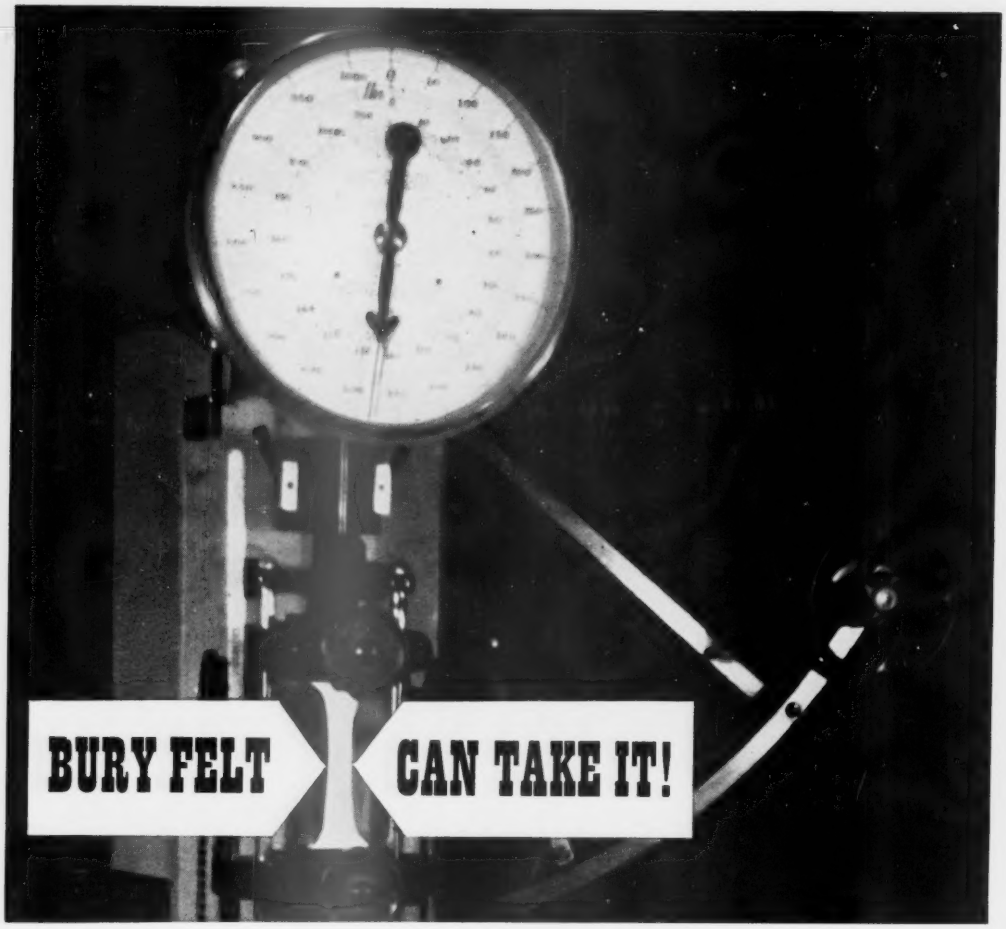

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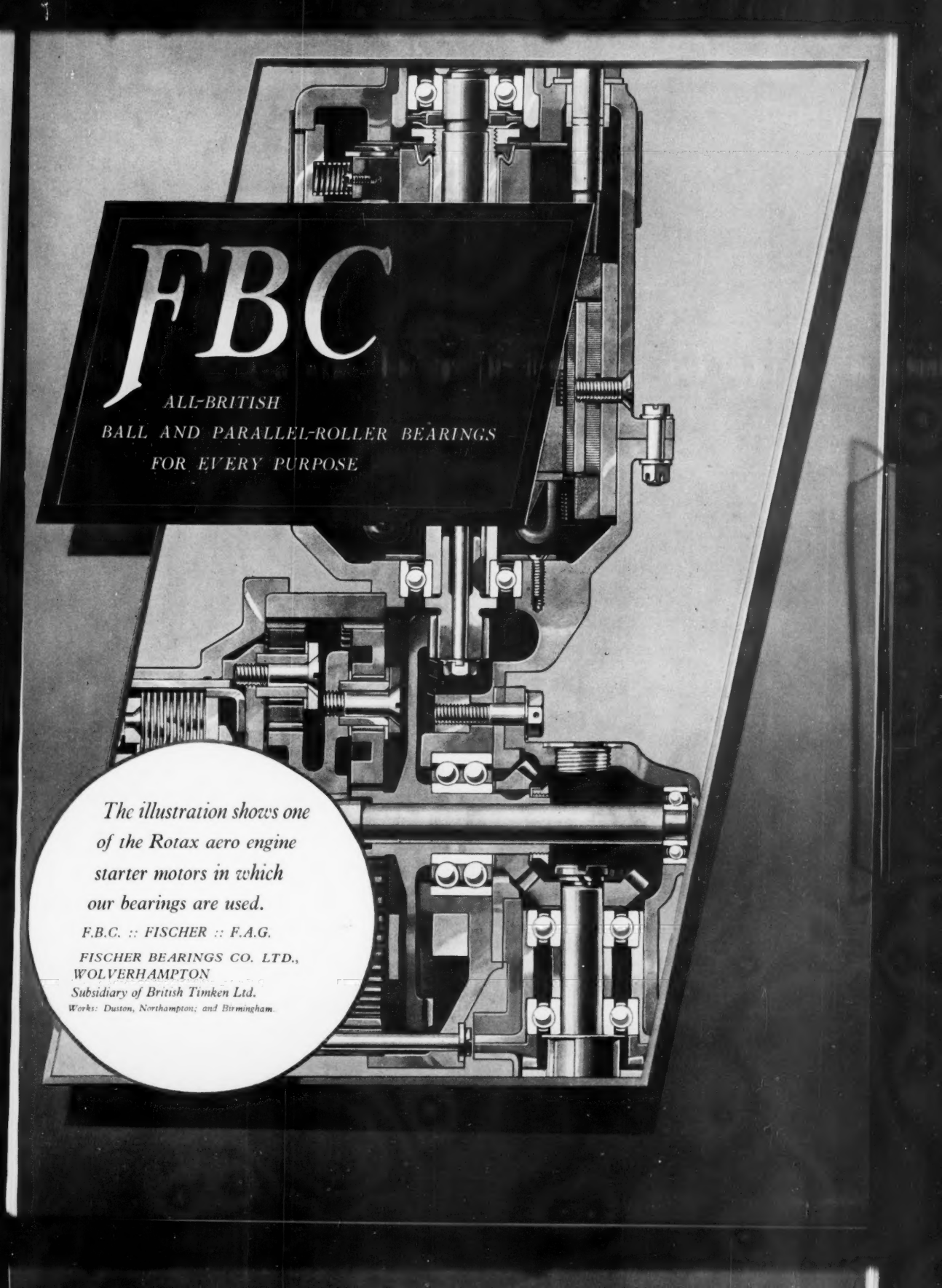
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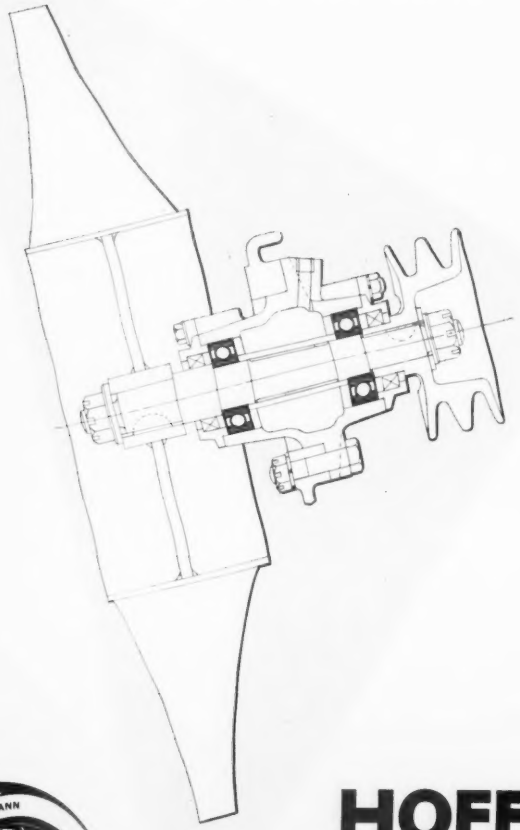

HOFFMANN

HOFFMANN BEARINGS

The well cooled engine runs far sweeter than one overheated. The fan plays its part in the cooling system and its reliability largely depends on the bearings fitted. Sweet running is a well known attribute of the Hoffmann Bearing.

Drawing by courtesy of Guy Motors Ltd., Wolverhampton.

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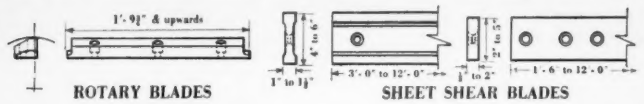
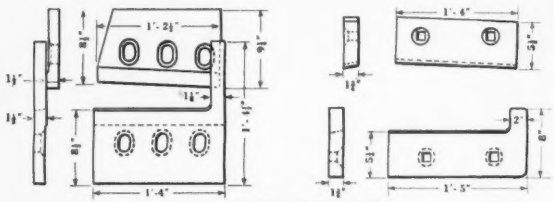


ROTARY BLADES

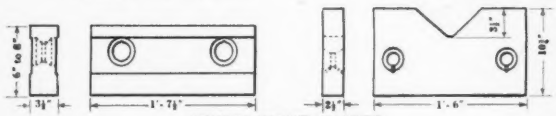
SHEET SHEAR BLADES



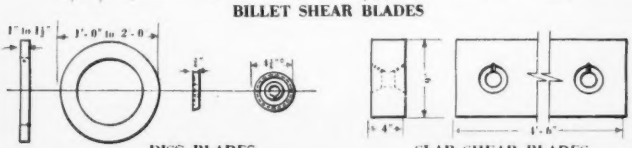
BAR SHEAR BLADES

FLYING SHEAR BLADES

FINISHING SHEAR BLADES



BILLET SHEAR BLADES



DISC BLADES

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FLORIDA 12 HR. GRAND PRIX OF ENDURANCE..Outright Winner..FRAZER-NASH
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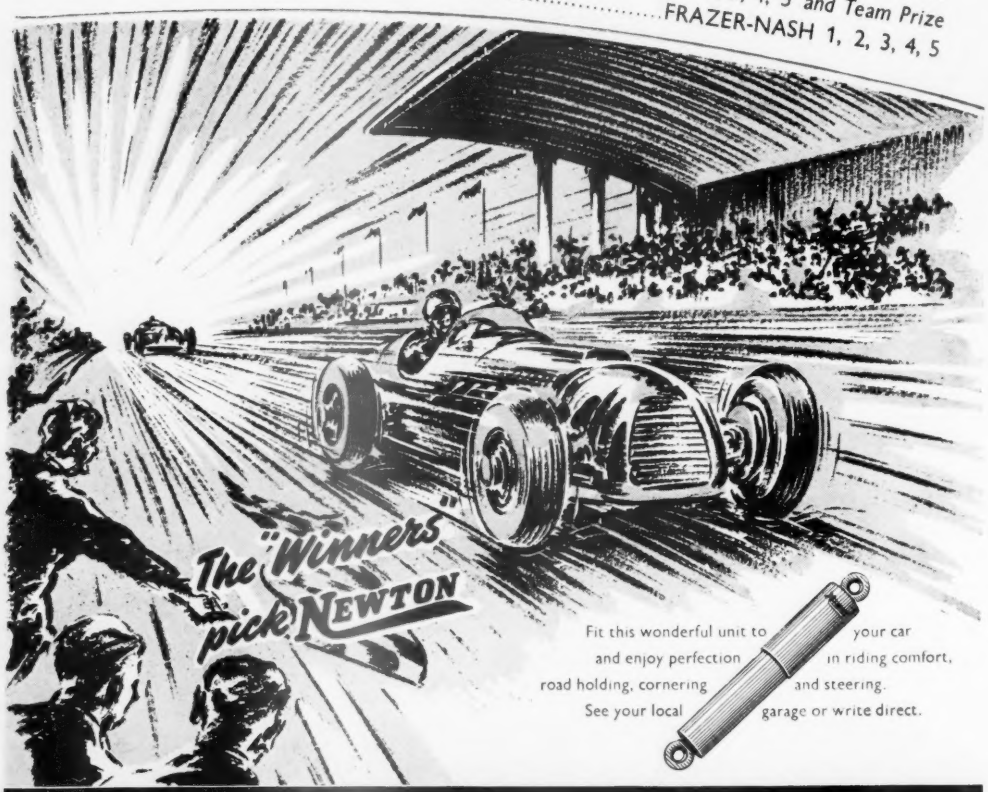
ULSTER T.T.....All Records Broken.....JAGUAR 1, 2, 4
TARGA FLORIO.....FRAZER-NASH 1
SILVERSTONE (3-LITRE).....JAGUAR 1, 2, 3, 4, 5 and Team Prize
(2-LITRE).....FRAZER-NASH 1, 2, 3, 4, 5



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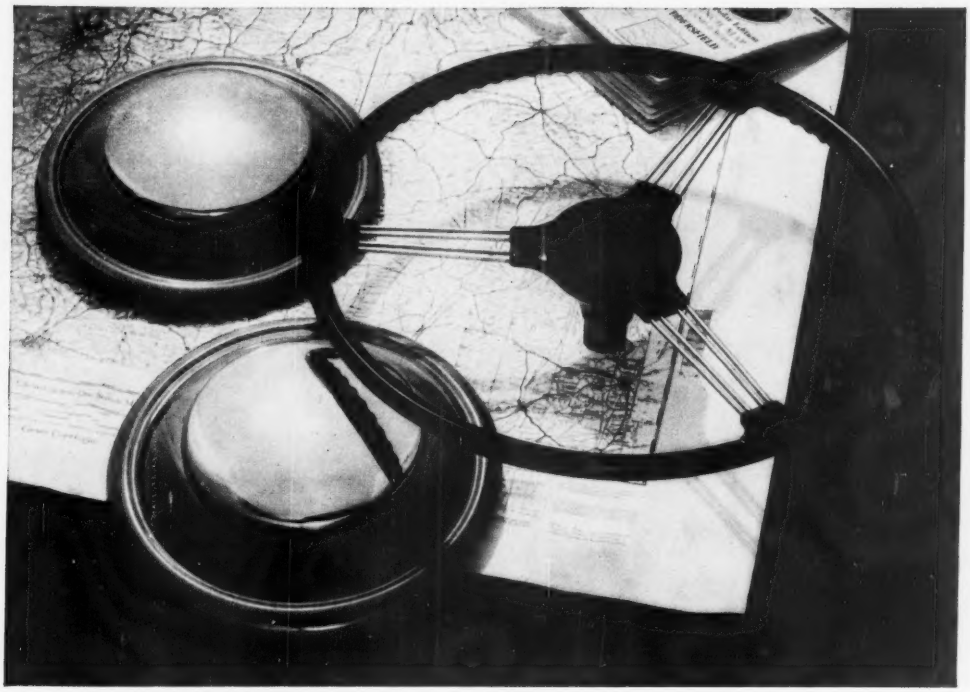

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When the nation's needs permit, "Silver Fox" will be available to the discriminating motorist in ever-increasing quantities.

Our colour photograph shows Hub caps by courtesy of the Ford Motor Company. Steering Wheel by courtesy of Wilmot Breeden Limited.

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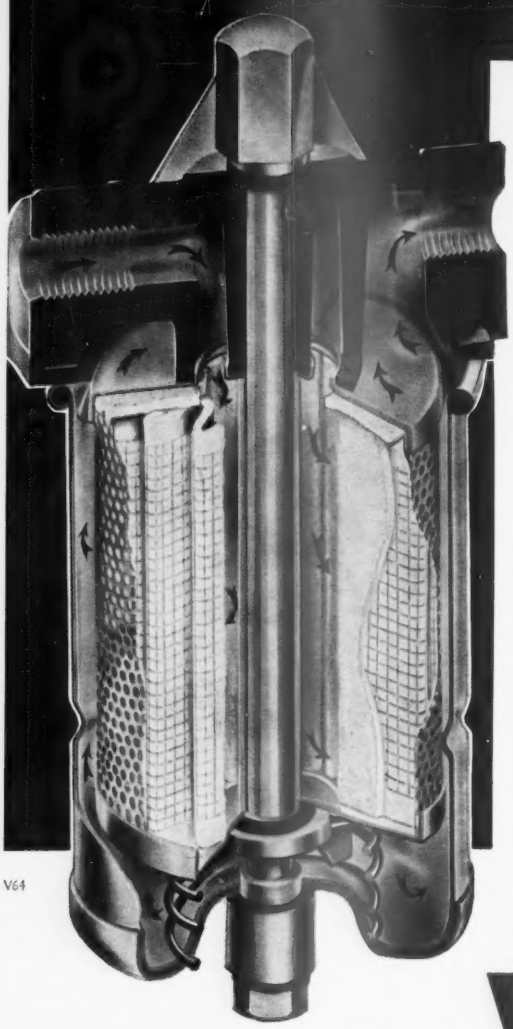
F259

CAN THAT FILTERED SLUDGE *Recirculate ?*



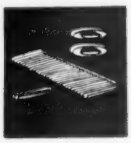
V64

One of the vital factors in the unrivalled efficiency of the VOKES full flow oil filter is the principle of filtration from the INSIDE to the OUTSIDE. This means that all the sludge and foreign matter which is extracted from the oil is safely locked in the centre of the filter and in no circumstances can it get back into the system. Consider these two examples:

WHEN OIL IS BY-PASSING THE ELEMENT

If the oil is highly viscous, then the VOKES direct flow device comes into operation for a short time to avoid the engine being completely starved of oil. The resilient rubber seal on the upper face ensures that when the oil once again flows through the filter, small grains of foreign matter will not prevent the seating from becoming completely oil-tight again. Here is Protection No. 1 against sludge being recirculated.

WHEN THE FILTER ELEMENT IS DUE FOR RENEWAL



Should the normal servicing and replacement of elements be neglected and the felt element become so completely clogged that the filtering medium can no longer operate, then again, the direct flow device *must* come into operation to prevent the engine being starved of oil. Again at such times the filtered sludge remains firmly trapped in the centre of the filter and cannot pass back into the system.

Here, then, is a unit which filters all the oil all the time . . . a medium which gives filtration in depth . . . a direct flow device which comes into operation only when the oil is extremely viscous or when the element is choked due to neglect . . . a direct flow device which is foolproof and which cannot allow sludge to recirculate.

★ *VOKES FABRIC ELEMENTS ARE CLEANABLE*

They give greater economy in the long run and ensure that plant and machinery are not put out of service through the non-availability of spare elements in remote places.

VOKES

Pioneers of scientific filtration

VOKES LIMITED · GUILDFORD · SURREY

VOKES (CANADA) LTD., Toronto *Represented Throughout the World* *VOKES AUSTRALIA PTY., Sydney*

This speaks for itself!

The Spring Eye Bush* illustrated below, removed from a Leyland Chassis fitted with a **Syndromic Automatic Mileage Controlled Lubricator** showed NO APPRECIABLE SIGNS OF WEAR AFTER THE VEHICLE HAD COMPLETED 49,850 MILES!

Such is the report of Messrs. Leyland Motors Ltd. to whom the Bush was sent for examination. The report concludes: "The Tecalemit Syndromic Chassis Lubrication Equipment fitted to this machine has proved most effective."

FOLLOW THE LEAD OF FLEET OWNERS AT HOME AND ABROAD WHO ARE CUTTING OPERATING AND REPAIR COSTS by lubricating their vehicles the modern and effective way.

* *All other bearings lubricated by this system were found to be in the same perfect condition.*

TECALEMIT
The Authority on Lubrication
PLYMOUTH & BRENTFORD

T.364

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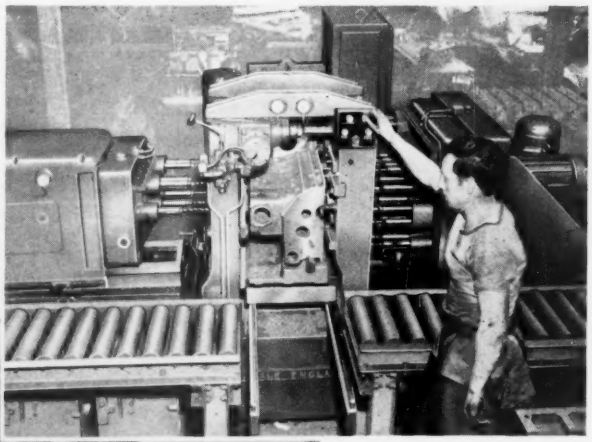
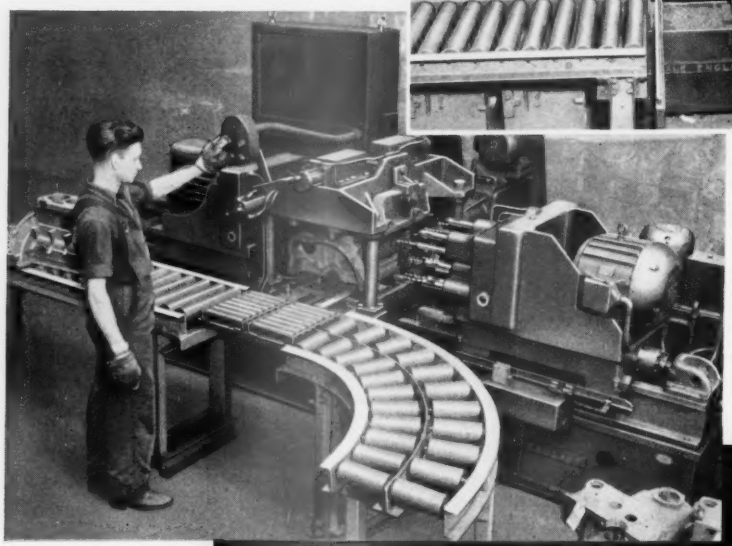
SPEED PRODUCTION AT

FORD MOTOR COMPANY LTD.

ARCHDALE specials are specially designed for high production at low cost. They play a big part in the production of the new FORDSON MAJOR tractor and the illustration opposite shows a 3 way multi-drill engaged on cylinder blocks. Operations include: REAR END, 9-$\frac{7}{16}$" and 1-$\frac{9}{16}$" holes drilled and 3-$\frac{5}{16}$" holes drilled and reamed; SUMP FACE, 24-$\frac{5}{16}$" and 10-$\frac{1}{2}$" holes drilled.

The lower illustration shows a second machine drilling the valve and water jacket sides of the block and the auxiliary drive bore.





Our Technical Staff are always pleased to co-operate with you on the design of special machines to improve your own production. Our wide experience is at your disposal upon request.

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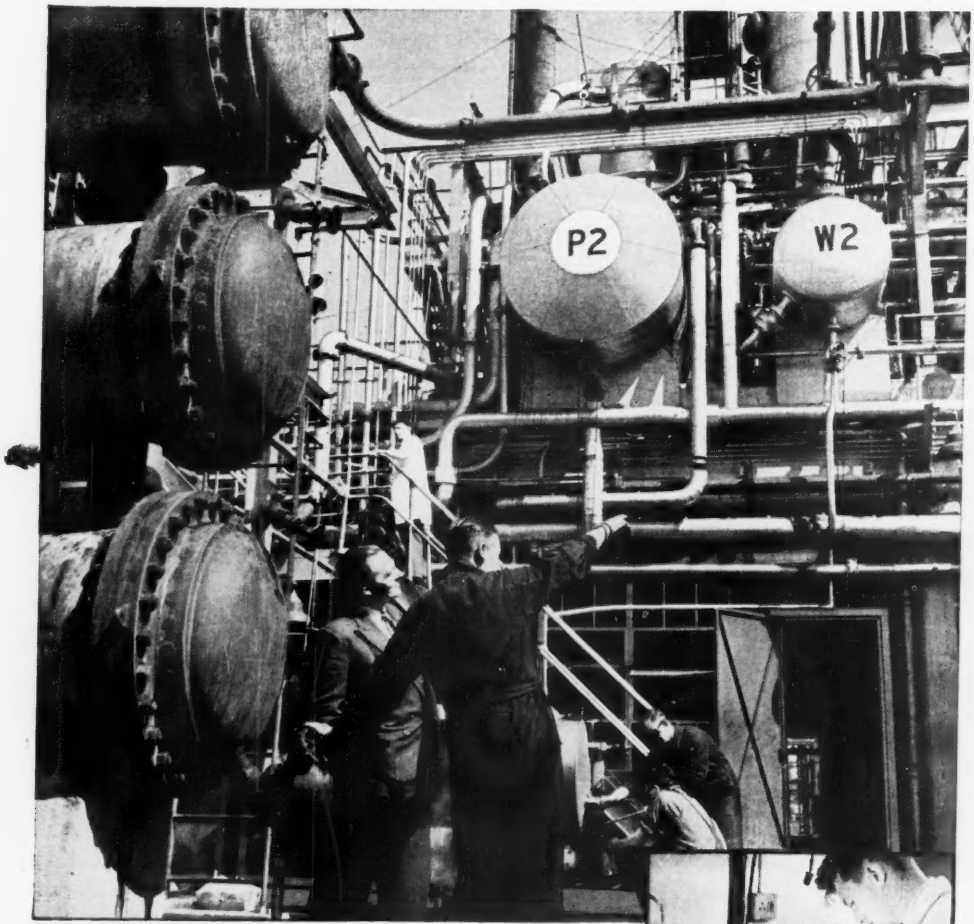

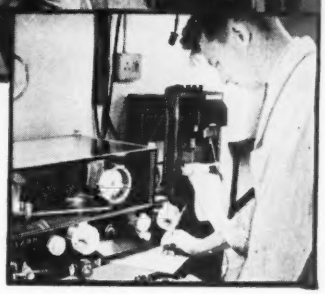

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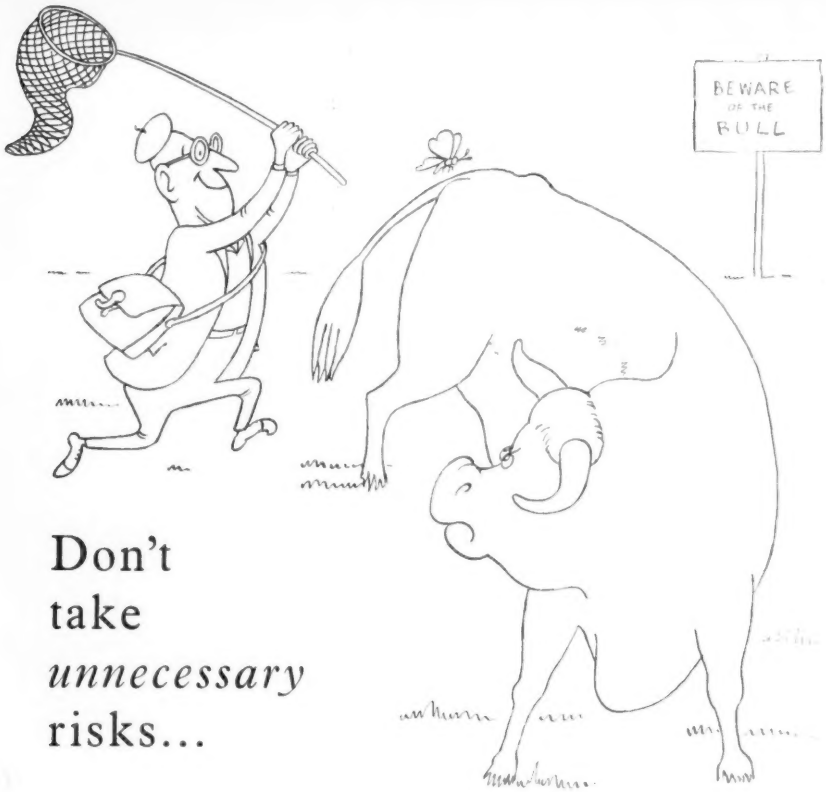

Don't take *unnecessary* risks...

IT looks a 'natural'—a rare and golden opportunity; but see the trouble it causes this near-sighted naturalist. Yet it's so *easy* to be misled by appearances—every day someone or other is finding himself on the horns of a dilemma through leaping before he looks. Not only light-hearted butterfly hunters, but hard-headed business men—it's just as easy to be led astray in the factory as in the field. You take a leap in the dark, for instance, every time you buy important components of uncertain quality. And speaking of leaps, let's talk about Springs . . .

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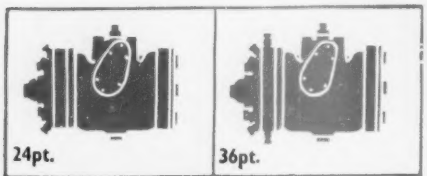

- ADAPTABLE AS SHOWN IN DIAGRAM.
- FULLY AUTOMATIC.
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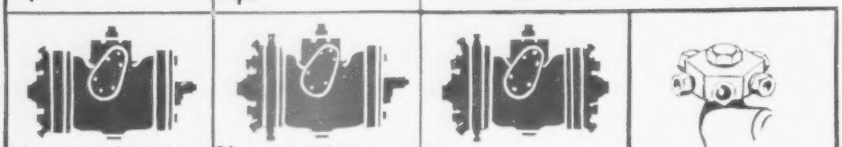

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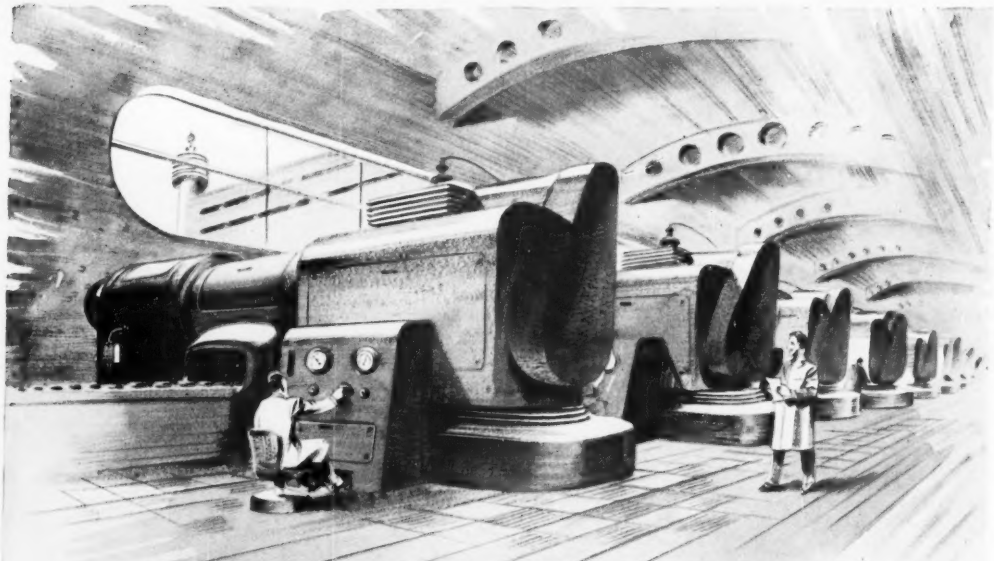

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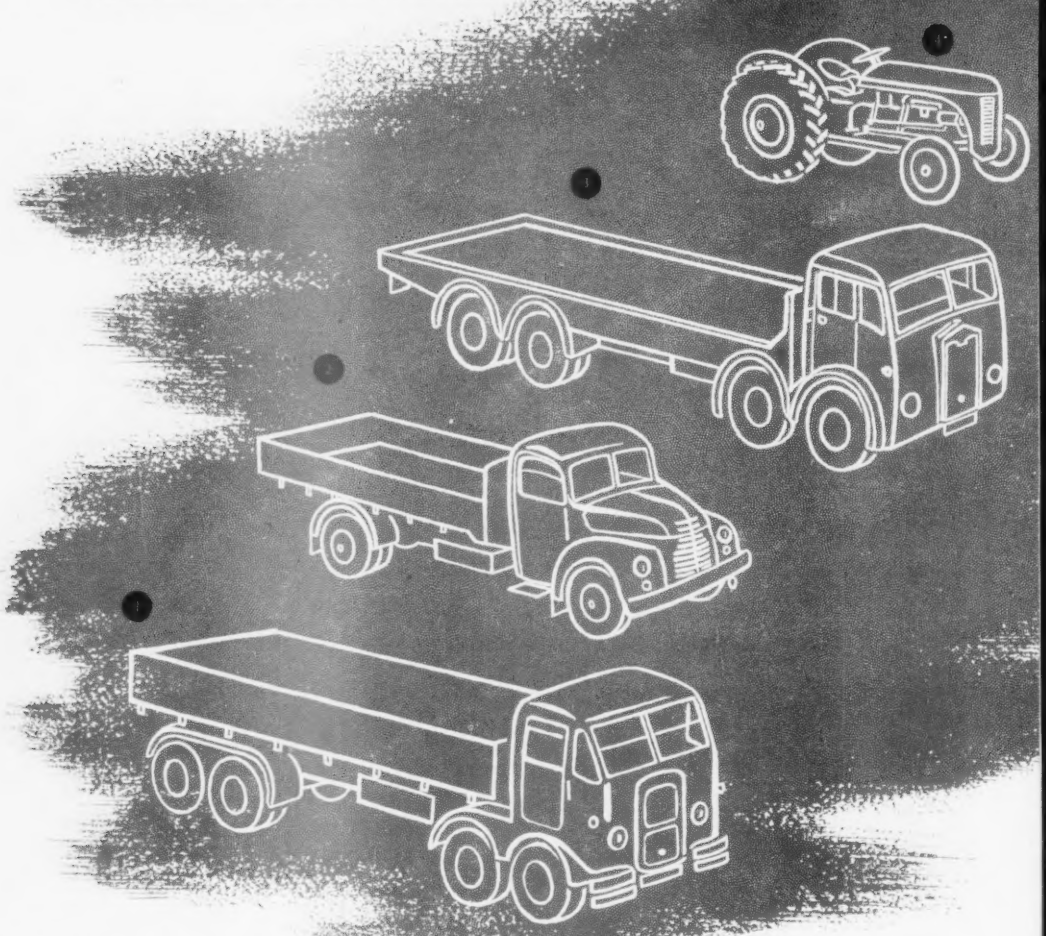
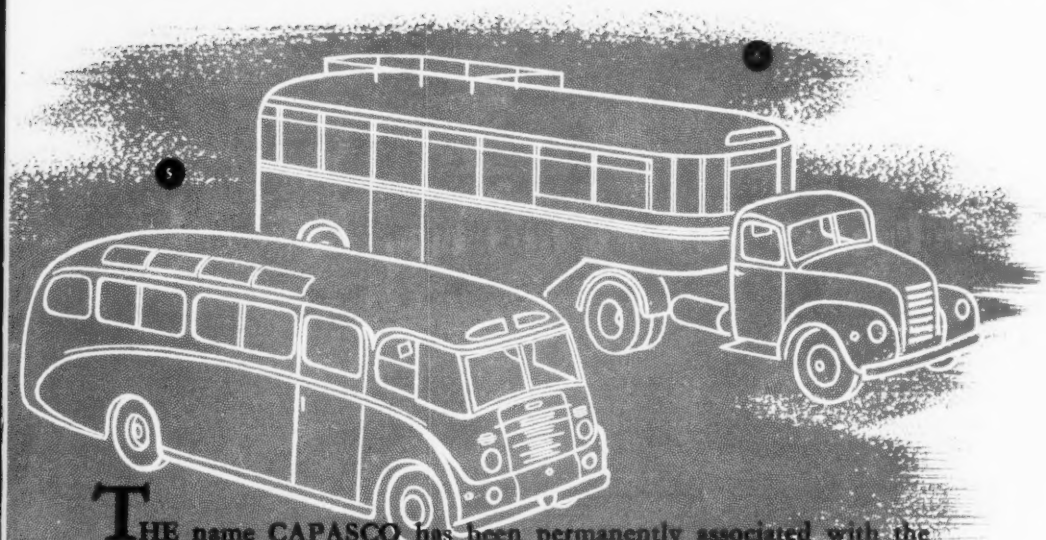


1 Scammell 15-ton Rigid 8-Wheeler. **2** Leyland 'Comet 90' Truck Model ECO2.1R. **3** Albion 8-Wheeled Heavy Duty Vehicle. **4** Ferguson Standard Tractor. **5** Tilling-Stevens Express Type. L4MA8. **6** British Trailer Company's Airflow II 50-Seat Semitrailer Coach.

STILL FOREMOST



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CAPASCO pioneered the way, and is still leading this highly specialised field. CAPASCO Moulded Brake Linings are daily proving their efficiency and reliability under the most arduous conditions and in all forms of Transport.

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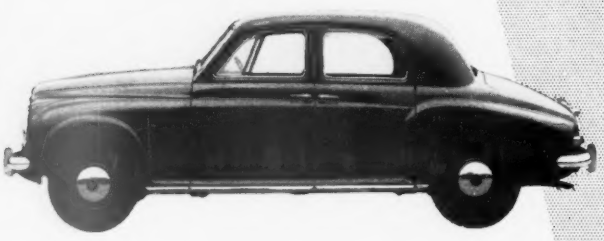
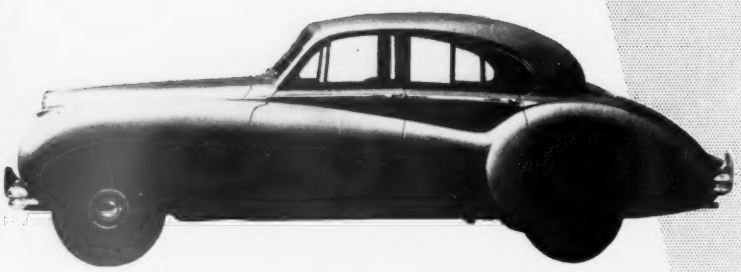


JAGUAR



The manufacturers of these outstanding cars—like many manufacturers in this and other industries—use Philidas locknuts because these are :—

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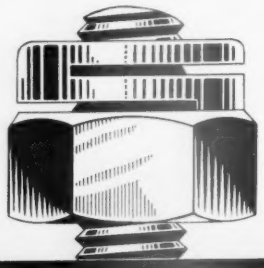
- ★ *Consistently efficient after repeated applications and removals.*
- ★ *Manufactured in the usual thread types.*
- ★ *All metal, one piece.*

Write for details of the full range of Philidas nuts.



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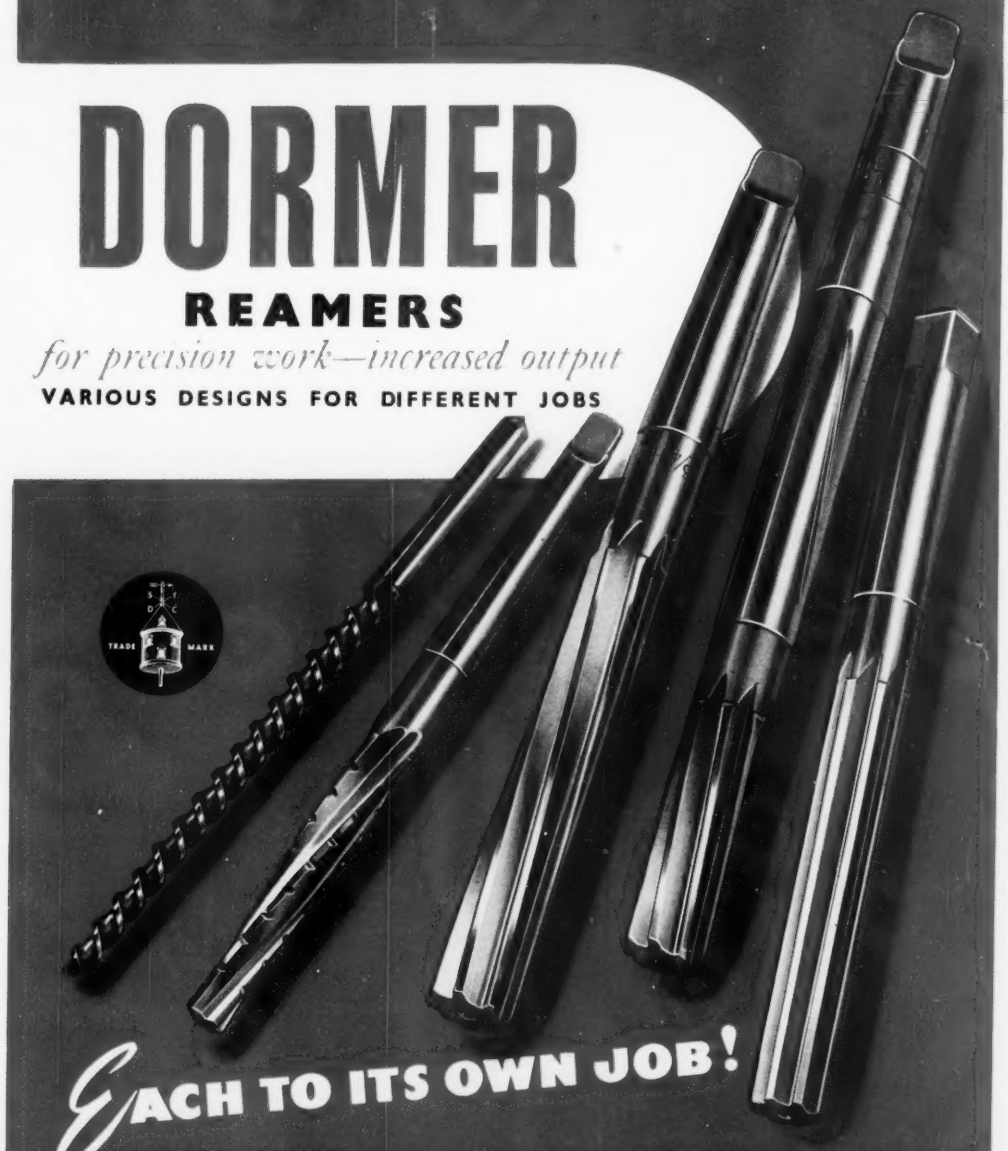

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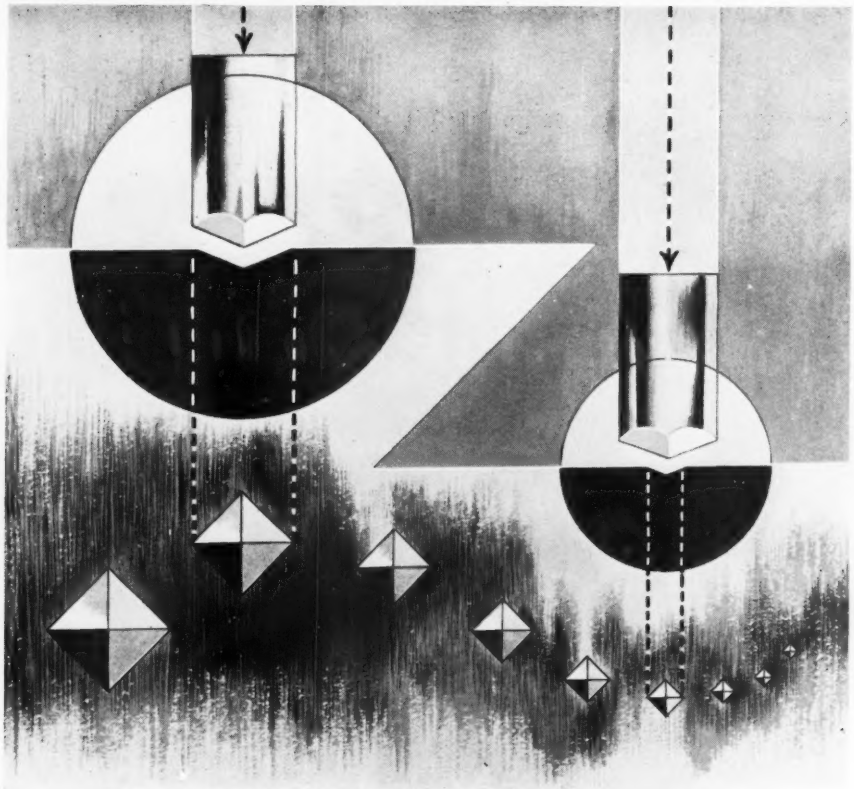

harder the smaller

The accuracy of a hardness testing instrument depends on a diamond indenter. The diamond working face is in the form of a polished cone or pyramid. The measurement of the indentation produced by this form under a known load indicates the hardness of the specimen. The smaller the indentation the harder the material is known to be.

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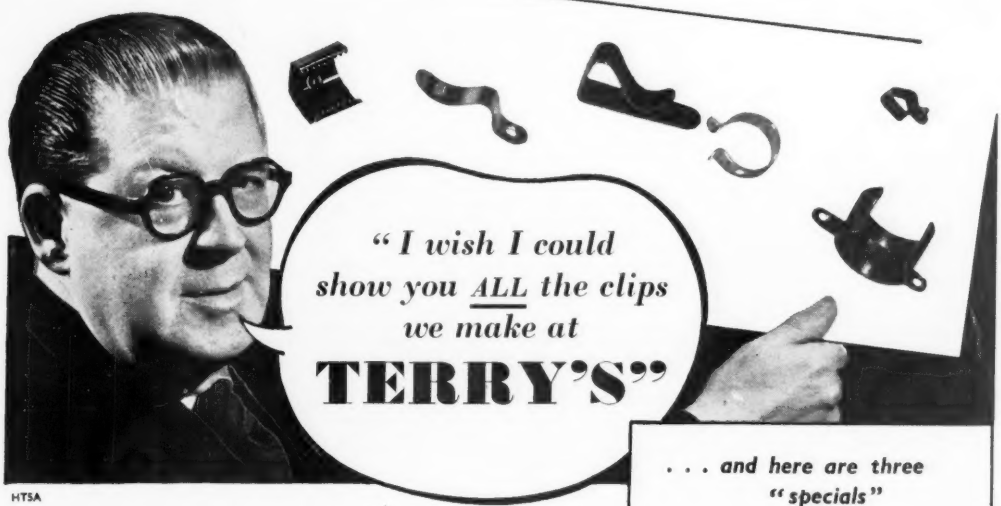

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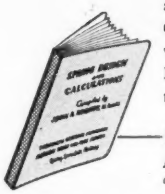

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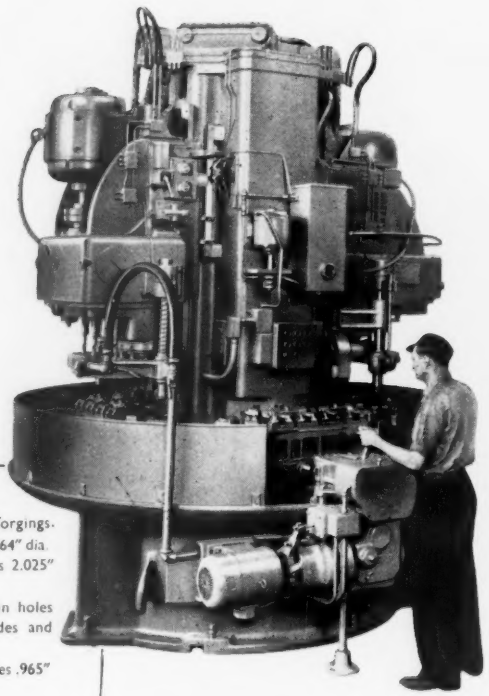
4-STATION AUTOMATIC INDEXING MACHINE



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Station No. 1.	Load and unload 4 rod forgings.
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Connecting rod forgings, loaded four at a time in special fixtures, receive five separate machining operations each in this high-speed centre-column type indexing machine. Consisting of three vertically-mounted, multiple-spindle heads, the unit operates a total of 24 toools. An 80-inch hydraulically-indexed rotating table carries the rods through each of the four stations in a cycle time of 55 seconds. Loading and unloading is facilitated though the application of a lever-operated power wrench which permits sustained high-speed operation with minimum operator fatigue.

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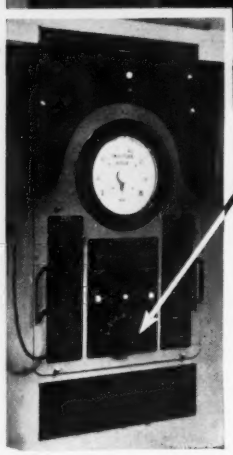

CENTRAL PANEL CONTROLLING 10 CONVEYORS AND 3 ASSEMBLY TRACKS CENTRAL DIAL INDICATES TRACTORS PER HOUR

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Photograph by the courtesy of THE STANDARD MOTOR CO. LTD.

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for their Conveyor and Assembly Track Drives in preference to older conventional drives

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Obviates variable-speed gearboxes and consequent belt or chain drives.

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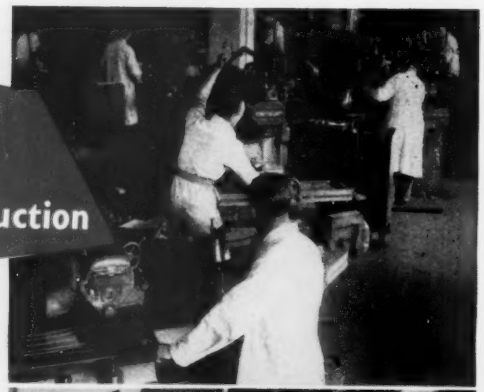

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This type of 2% Carbon — 14% Chrome Tool Steel is recommended for exceedingly high duty work such as the blanking of Hard Steels, Stalloy and kindred laminations in Silicon Iron and for many other tools where high duty and long service are desired. It constitutes probably the greatest advance in tool steel production since the invention of High Speed Steel. After hardening, the temper may be drawn over a much wider range than is permissible with ordinary alloy tool steels.

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And chronic alcoholics
Who never see phenolics
May do without the help
Of polytetrafluoroethylene.

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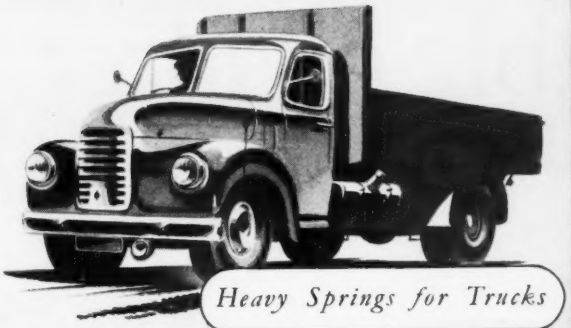
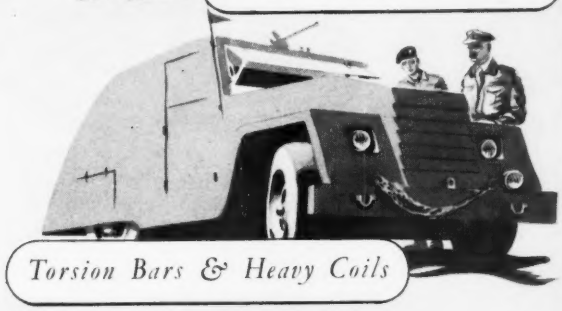


Heavy Springs for Trucks



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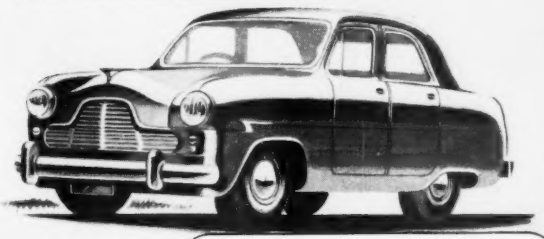

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Suspension Engineers

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Detachable oil filter

element easily inspected and replaced

This new AC partial-flow oil filter with replaceable element meets the increasing demand for a filter that can be removed for inspection and replaced every 8/10,000 miles. It provides a permanent installation for coupling into a by-pass oil supply system and the filtering element can be replaced without disturbing pipe connections. Sump oil is filtered on an average of ten times an hour. This means less motor wear and longer motor life — the objective of every motor manufacturer.

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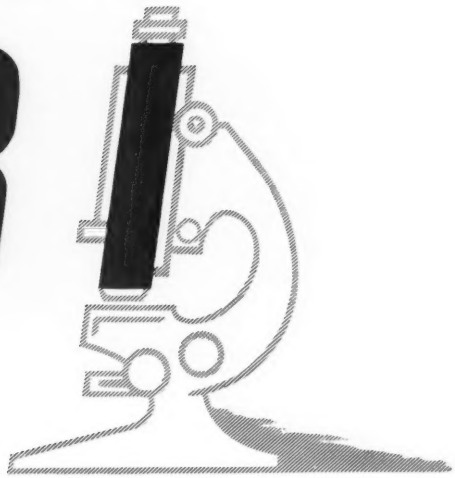

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From every batch of Ferodo friction materials, samples are taken and ruthlessly tested for efficiency and durability. On the M.I.R.A. Track (of which Ferodo Limited are one of the largest users) the final and practical proving of the finished product takes place. All this, and the ceaseless experimental work in the Ferodo Test House, ensures that Ferodo friction materials maintain their high standard of reliability, efficiency and durability that makes them first choice for safety all over the world.

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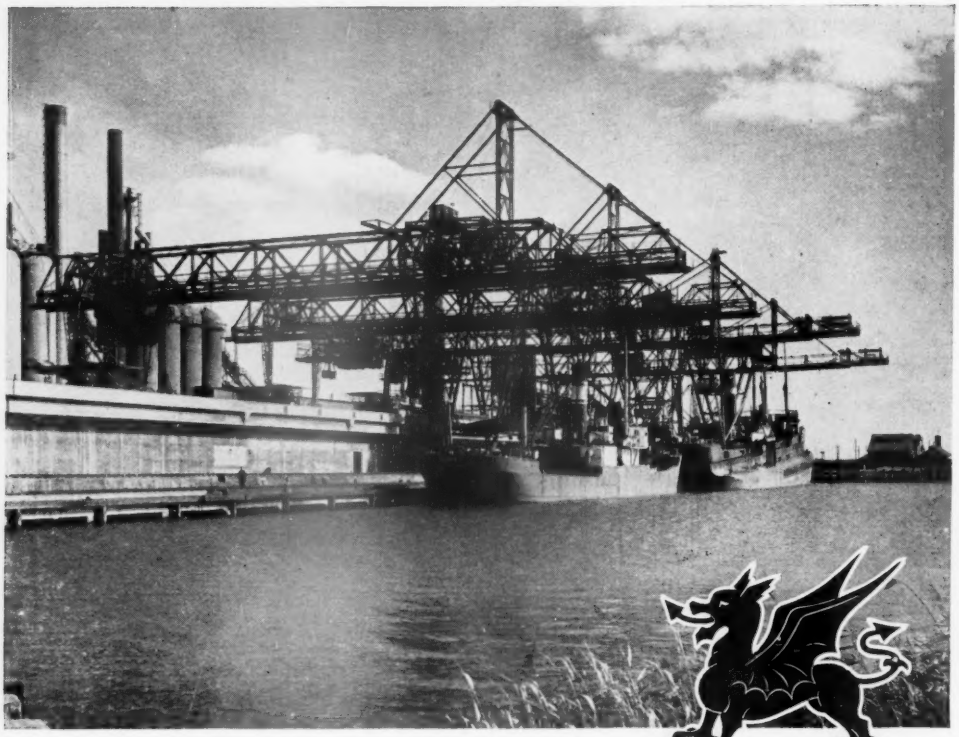
FERODO LIMITED CHAPEL-EN-LE-FRITH *A Member of the Turner & Newall Organisation*



Wharf at Margam Works showing Ore Unloaders

THE ORE UNLOADERS illustrated here can handle 500 tons of ore per hour. They are an important part of the new equipment which makes The Steel Company of Wales the most up-to-date plant of its kind.

PRODUCTS OF THE COMPANY ARE :—
Hot Rolled and Cold Reduced Sheets and Coils up to 72″ sheared width in qualities for auto-bodies, vitreous enamelling, extra deep drawing, etc. · Galvanized Flat and Corrugated Sheets · Electrical Sheets for Dynamos and Transformers · Blackplate · Hot and Cold Reduced Tinplate both hot dipped and electrolytically tinned · Plates $\frac{1}{8}$″ thick and upwards by up to 72″ wide · Slabs · Basic Pig Iron · Coke and By-Products · Sized Limestone.

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EFFORTLESS STEERING AND GREAT DURABILITY

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Tapered roller bearings (with detachable cones on the larger sizes).

Double bearing support to rocker shaft.

End-location adjustable.

Large angular movement.

Very compact box.

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THE 'MARLES' DOUBLE-ROLLER GEAR, made in a range of sizes covering every type of chassis.

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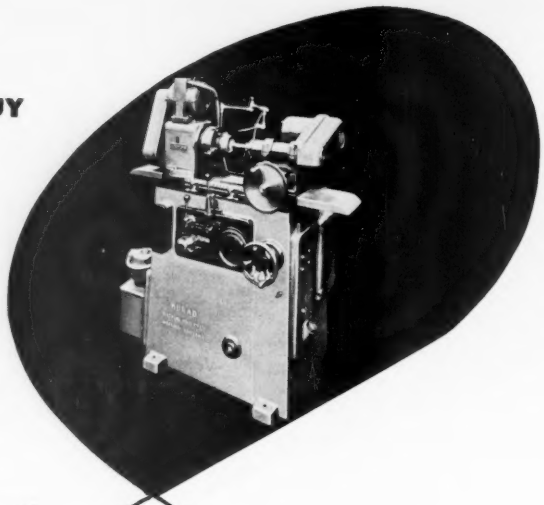

We were in a hurry. Month by month
we stepped up production of our capstan lathes
and as each bottleneck appeared
we opened it.
When the internal grinding bottleneck
appeared we were "stumped."
Delivery of another grinder such as we were
using was 37 months.
So What?
Well, we set to work and designed and built
our own and it's doing its job in fine style.
Sorry! We don't propose to build
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too busy making capstans to meet your insatiable demand.
Later? Perhaps.

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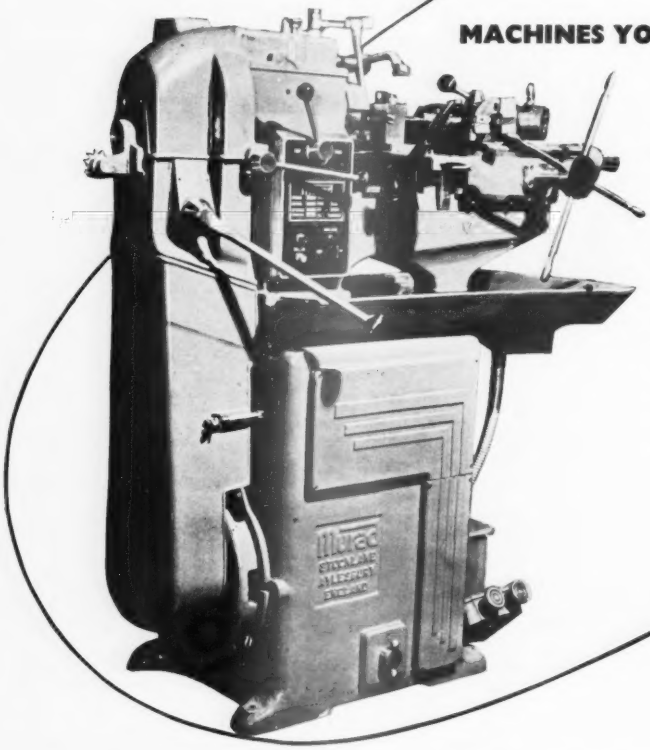

Even if you can't buy
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the MURAD 1" High Speed
Capstan Lathe. This is the machine
that holds unchallenged
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of capstan lathes.
That is why production
mounts week by week, month by
month and still we
can't catch up.
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Full details on application

Announcement of The General Electric Co. Ltd.

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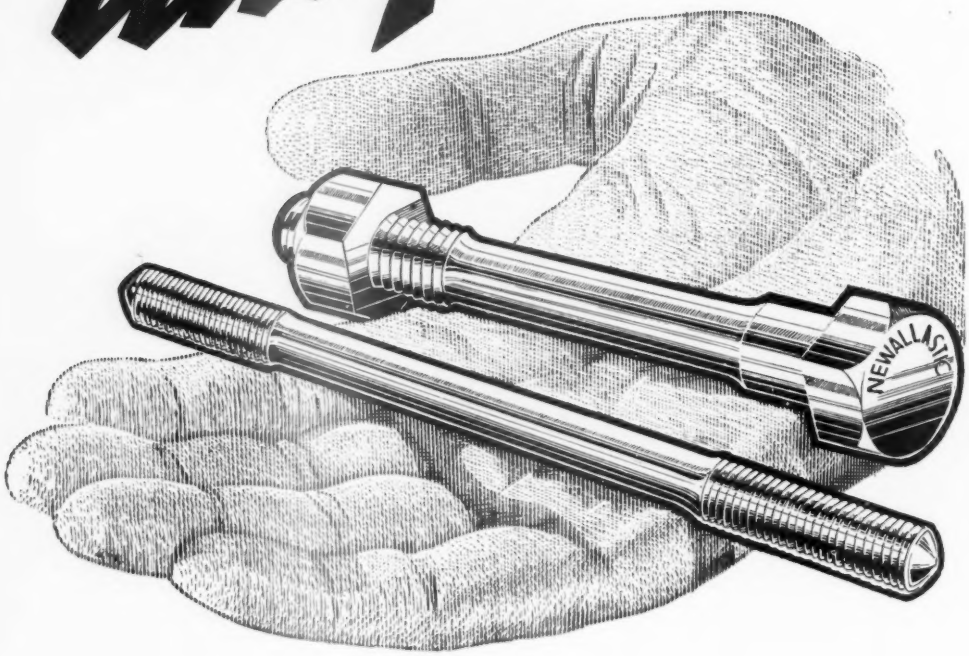

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" . . . Cromard liners . . . distributed among 501 engines . . . at the moment the figures which we have, show that after 115,000 to 120,000 miles the bore wear cannot be measured with a micrometer . . ."

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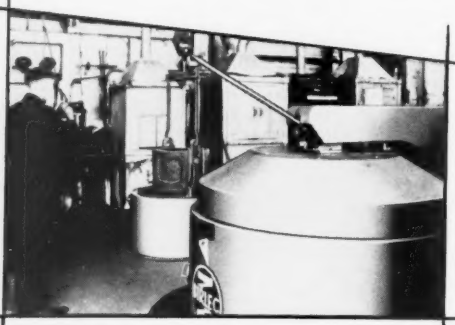
BIRLEC

gas carburising



in standardised Birlec pit furnaces

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Furnace Rating	Usable Dimensions	
	Diameter	Depth
40 kW.	1′ 4″	2′ 6″
65 kW.	2′ 0″	3′ 6″
85 kW.	2′ 3″	4′ 6″
150 kW.	3′ 0″	4′ 6″
1,800 cfh.	2′ 6″	4′ 0″

Gas carburising is not an all-that-tricky business — that's why so many manufacturers of gears and other traction components are now changing over to it from pack methods. Experience, however, still counts for something . . . and the Birlec range of standardised pit furnaces (electric or gas) will solve most gas carburising problems . . . it has done so far. 33 Birlec units are now installed or on order. If yours is a really large output of similar components requiring the same case depth, we can recommend a continuous furnace; and you may also be interested in the advantages of a " drip feed " atmosphere. Our experience covers that too. Why not send for further details? Publication No. 70 and other literature is available.

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Illustrations by courtesy of Cincinnati Milling Machines Ltd.— one of the many leading machinery and other manufacturers using Birlec gas carburising equipment.

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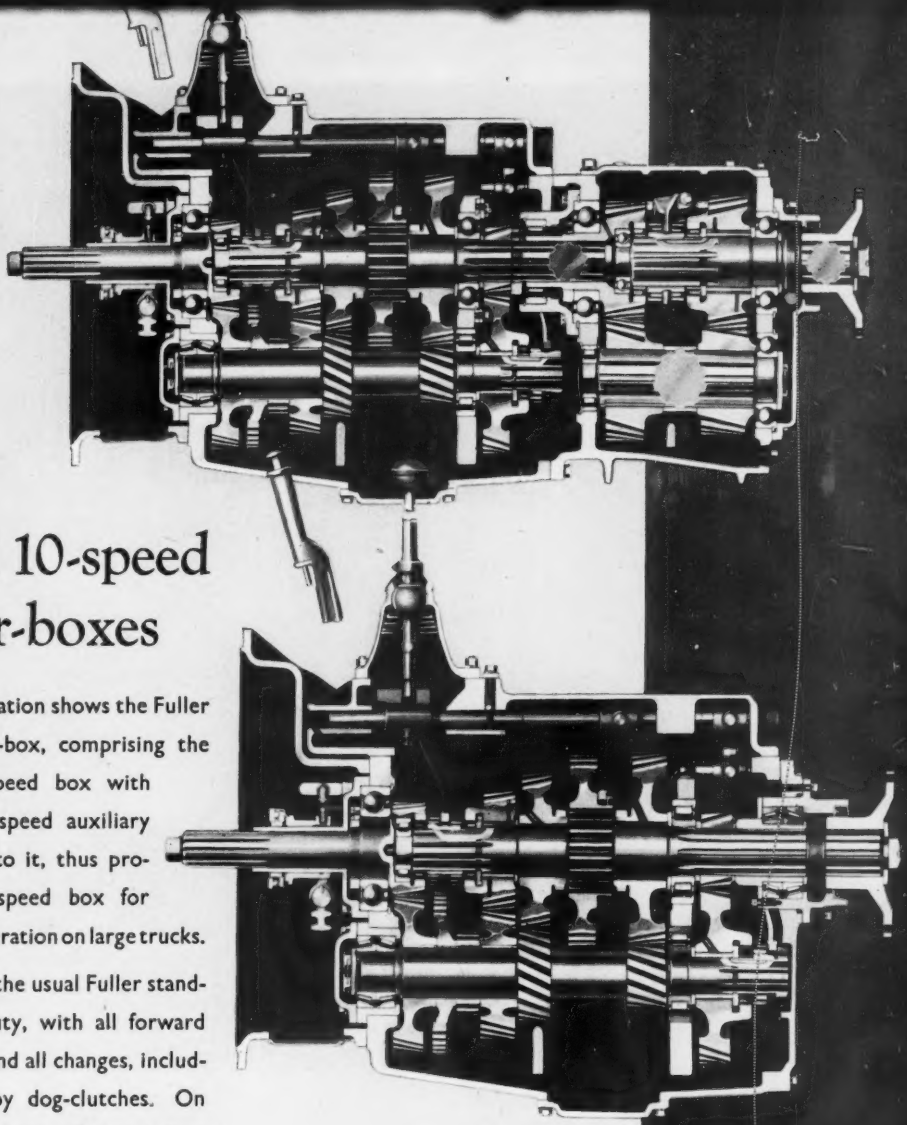

5 and 10-speed gear-boxes

The top illustration shows the Fuller 10-speed gear-box, comprising the famous five-speed box with a Fuller two-speed auxiliary box built on to it, thus providing a ten-speed box for heavy-duty operation on large trucks.

This unit is to the usual Fuller standard of high-duty, with all forward gears helical, and all changes, including reverse, by dog-clutches. On both of these boxes the gears are shot-peened and crown-shaved, to avoid stress concentration.

The lower illustration shows the Fuller 5-speed gear-box. Every gear is helical and engaged by dog-clutches and to reduce shaft deflection to a minimum the mainshaft is supported on three bearings, and the layshaft kept short, making one of the highest-duty gear-boxes ever produced.

Exclusive European Representatives
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Brock House, Langham Street, London, W.1, England
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Fuller

350 SIZES *available from stock*

Compo bearings — the bronze bearings with their own self-contained lubrication — are now available for immediate delivery. Compo bearings are made from powdered metals, die-pressed to extremely accurate dimensions. Ready for immediate installation without machining or treatment. There are over 350 sizes of the Compo standard cylindrical range that we can supply "off the shelf." Send today for a copy of our list of cylindrical stock sizes conforming to British Standards Specification No. 1131.

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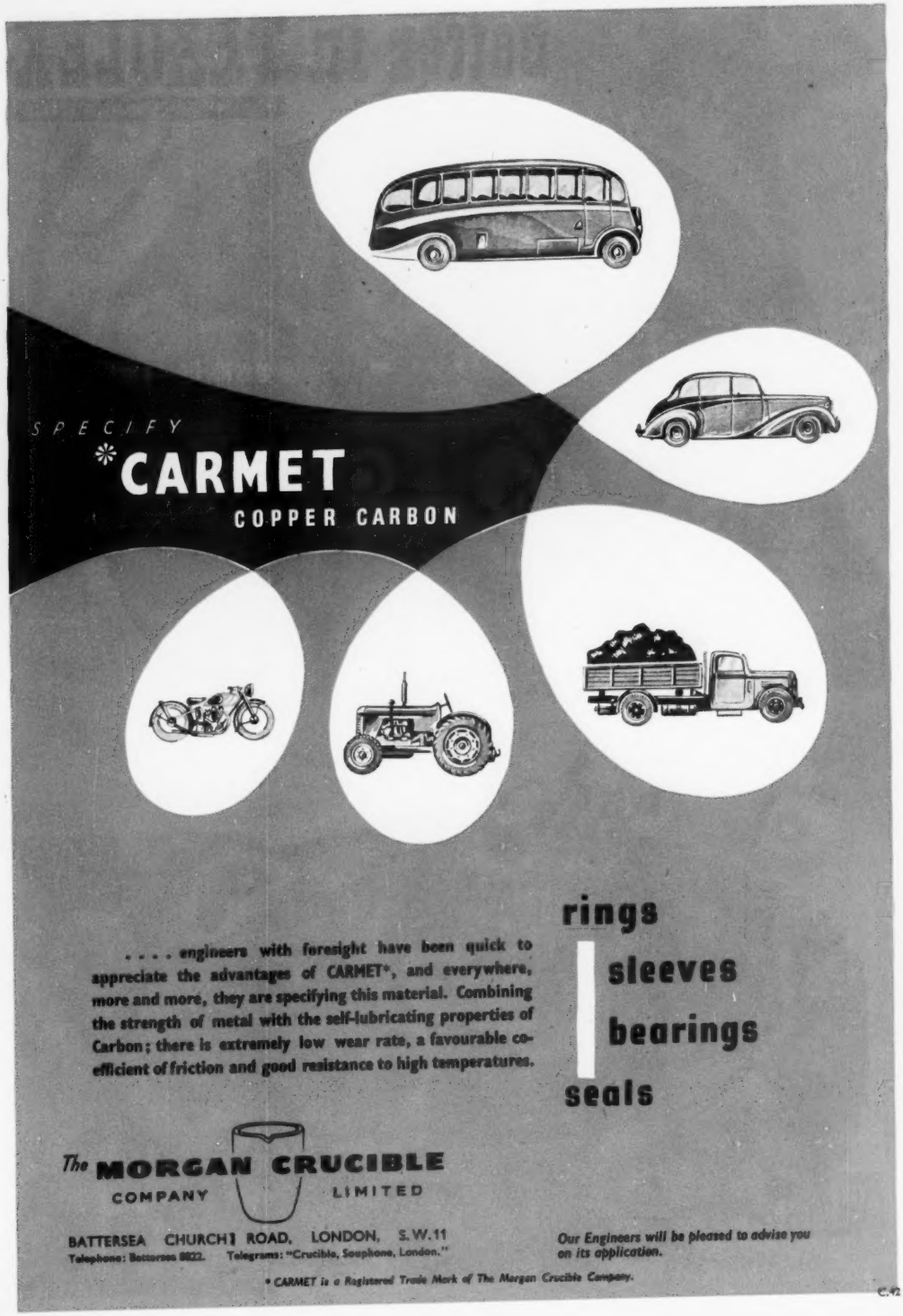
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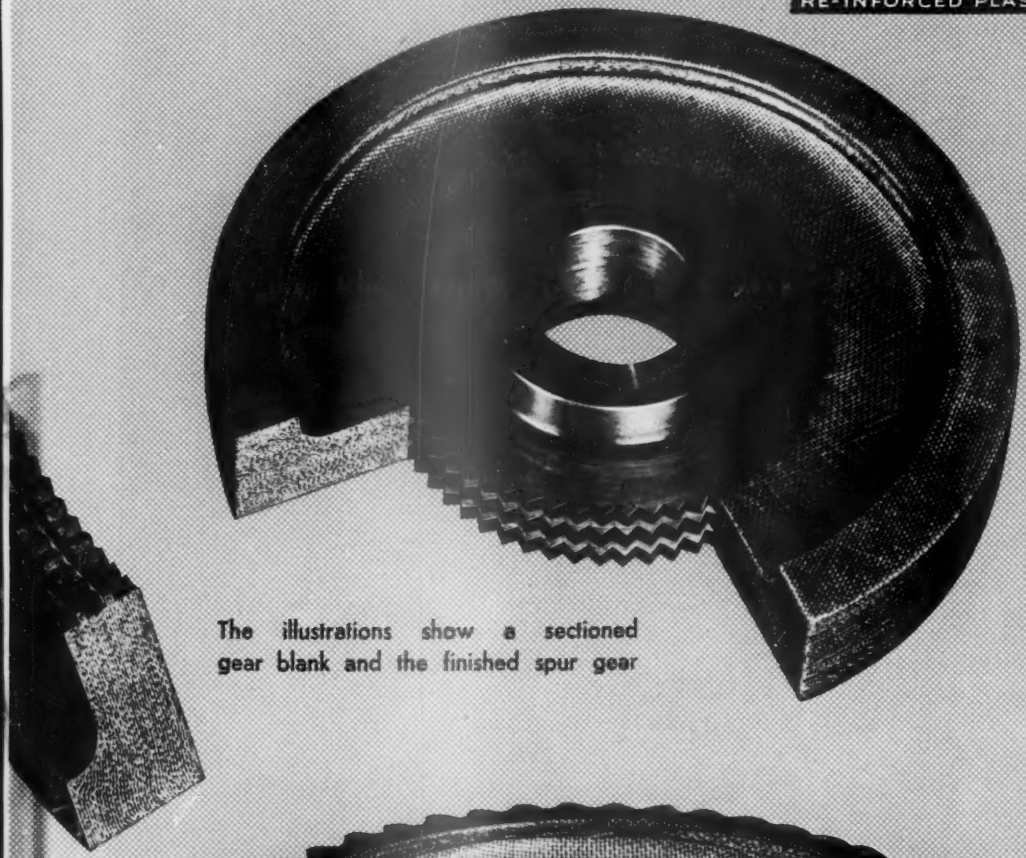
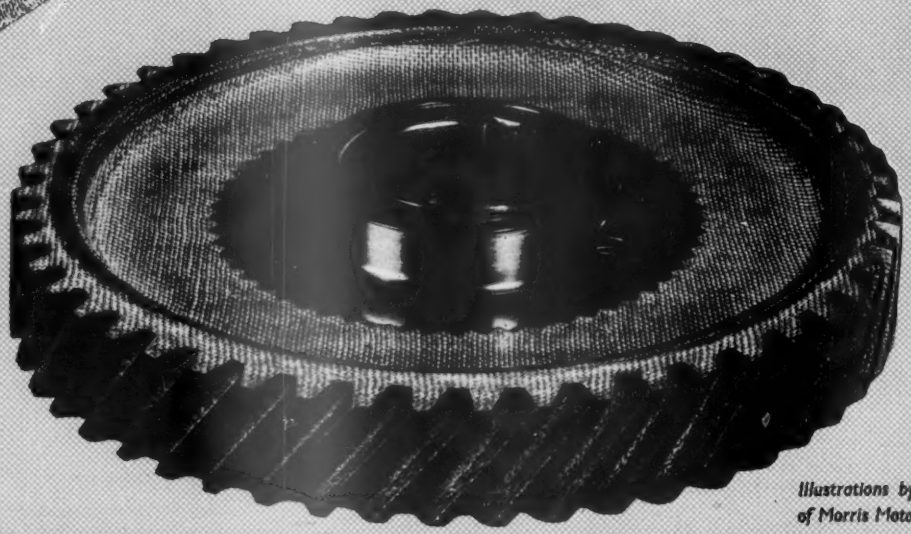


The illustrations show a sectioned gear blank and the finished spur gear



Illustrations by courtesy of Morris Motors Limited

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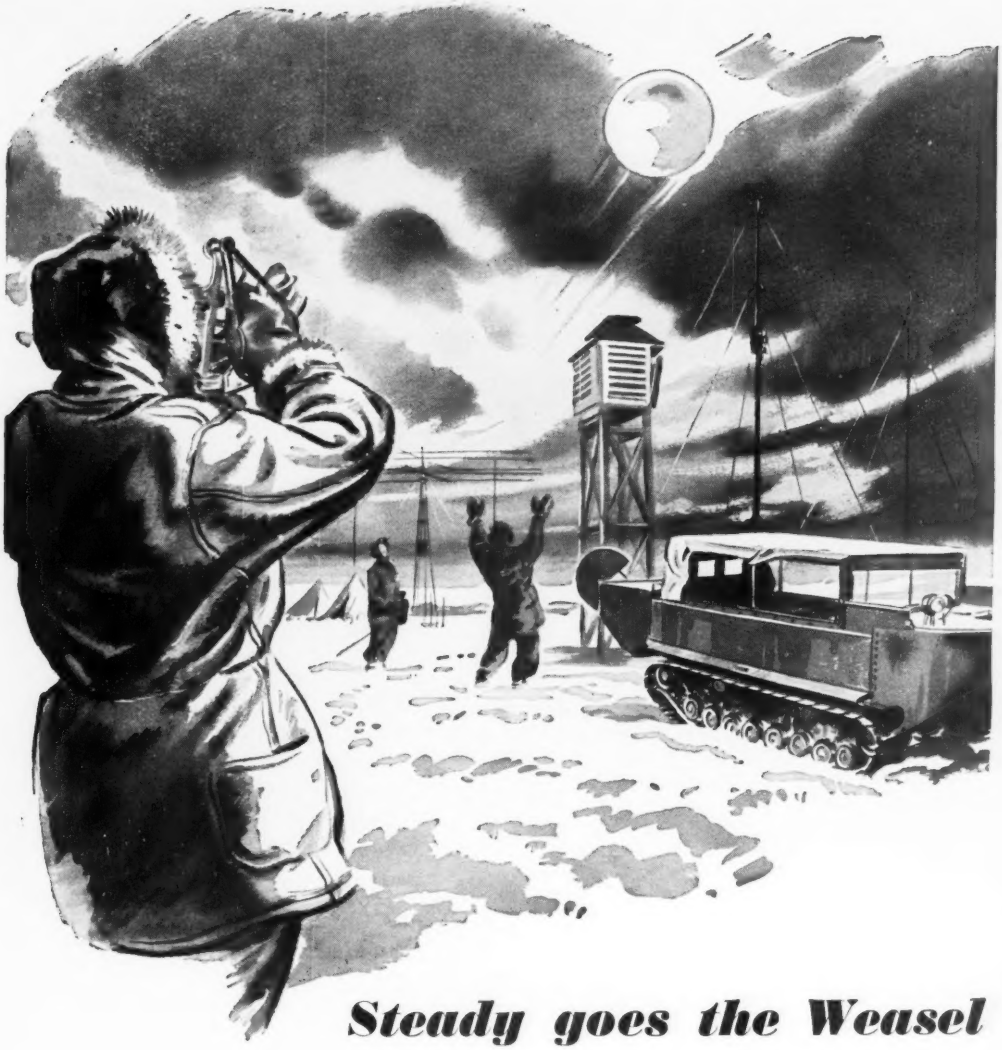

Steady goes the Weasel

He has been living for some time now on the line L. 70 degrees S., doing meteorological work. The terrain is difficult, mostly badly crevassed ice; and the temperature averages 40° below. Last year there was a lot of trouble with the dogs so this season all supplies have been brought down by weasel, which has behaved faultlessly. Of course it's powered with a diesel, which is fitted with Bryce Fuel Injection specially designed for the job. And the Bryce world wide service extends right down to the base.

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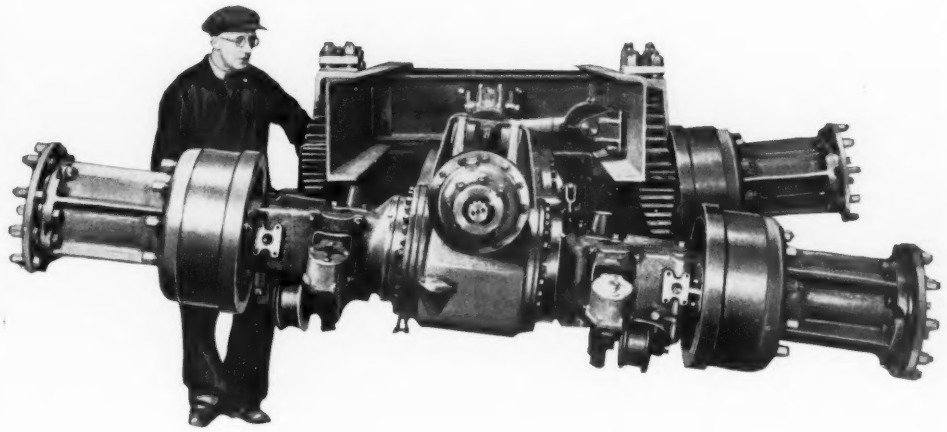

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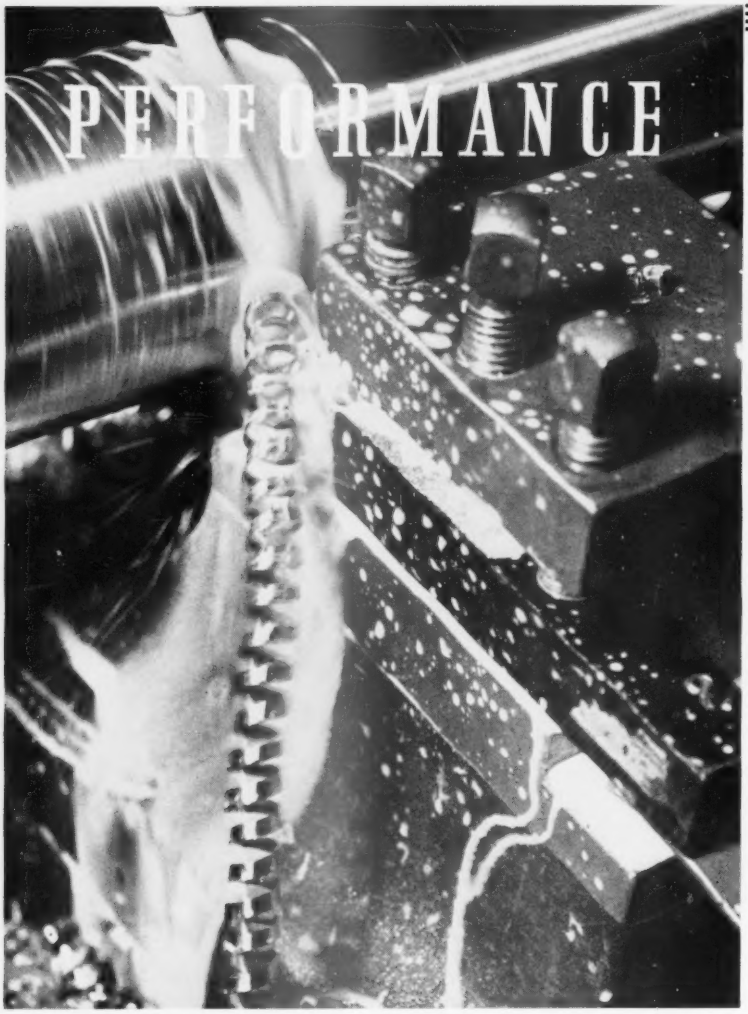

Photograph by courtesy of Messrs. Henry Wiggin & Co. Ltd.

This unretouched photograph shows a Cutanit tool coping effectively with a tough job. It is the heavy machining of a Nimonic bar for which operation Cutanit grade I.C.C. is unequalled.

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A hand upraised may stop a bus, but consider the effort required to start it again. A tremendous load is thrown on to the transmission. This happens not once but thousands of times in the average daily life of a bus. Designed to withstand the strenuous conditions of public service transport, Hardy Spicer propeller shafts and universal joints are supplied to the majority of public service vehicle manufacturers as standard equipment.

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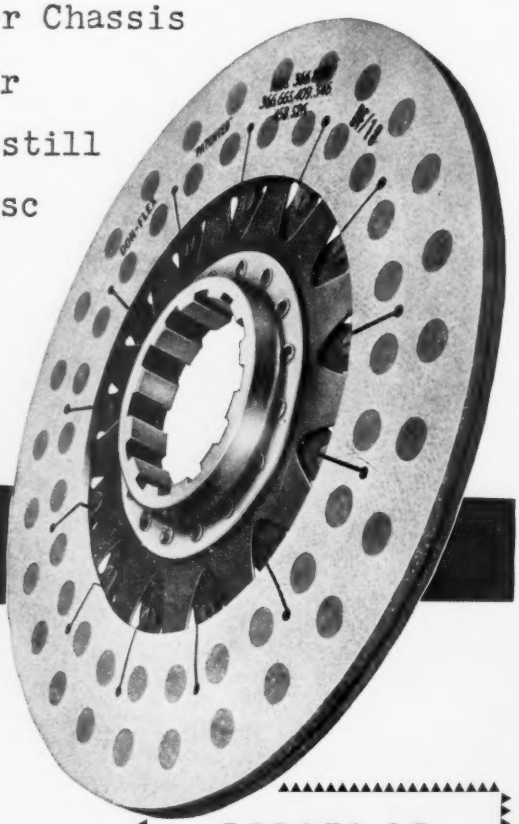

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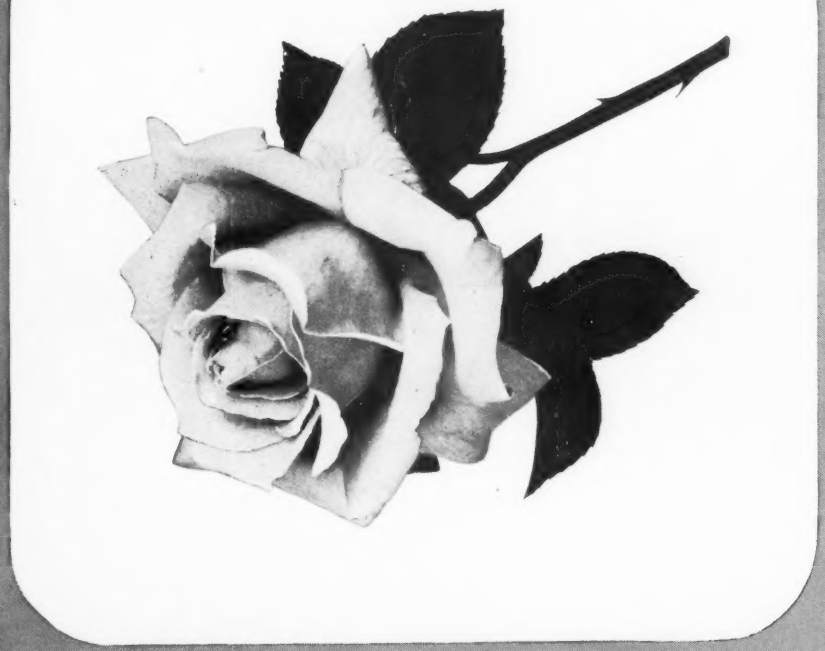

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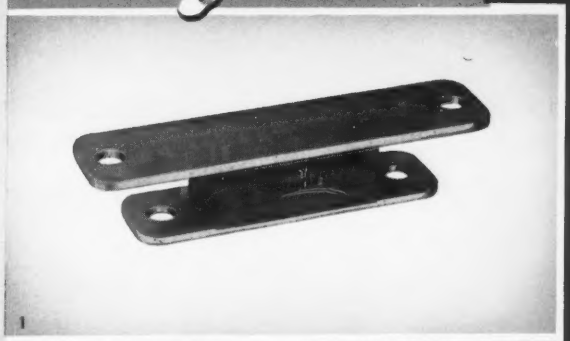
1. Front engine mounting (sandwich type).
2. Front engine mounting (Interleaved circular mounting).
3. 'Metacone' engine-mounting.
4. Metalastik torsional-vibration damper.
5. Metalastik patent ultra-duty pre-loaded bush.
6. Metalastik bonded-cone bushes for I.F.S.
7. Metalastik axial snubber bush.


1

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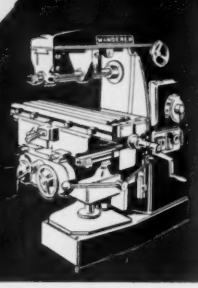
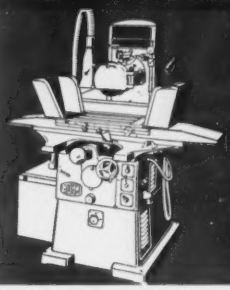
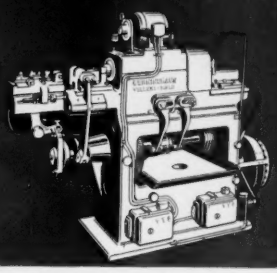


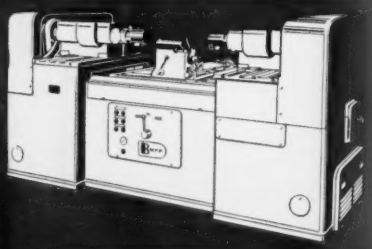
WANDERER. Millers, plain, vert. and univ. up to 14" x 50" table, and milling units.



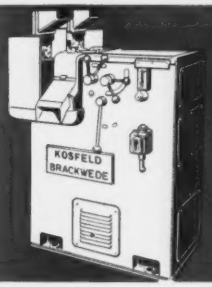
BLOHM. Horizontal surface grinders and drill bushes.



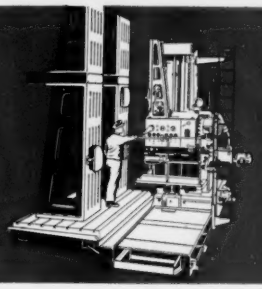
BERNINGHAUS. Single-spindle coiled stock automatic forming machines.



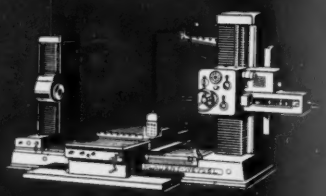
LUDWIGSBURGER. Superfine finishing machines and equipment.



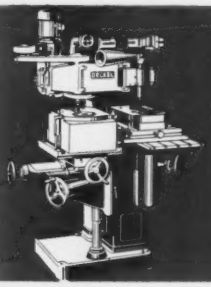
KOSFELD. Automatic nut tapping, facing and countersinking machines.



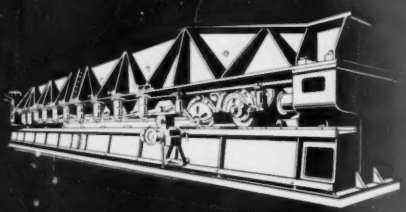
HEYLIGENSTAEDT. Vertical copying mills. Lathes and copying attachments.



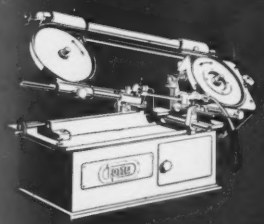
PLAUERT. Horizontal boring machines, 2¼" and 3¼" spindle dias.



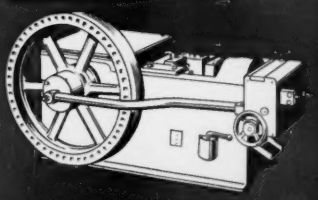
DECKEL. Engraving machines. Pantograph, profiling and tool millers.



SCHULZE & NAUMANN. Super high-speed plate shearing machines.



FORTE. Band sawing machines up to 10" capacity



KUHNE. Heading machines for bolts, nails, screws, balls and rollers.

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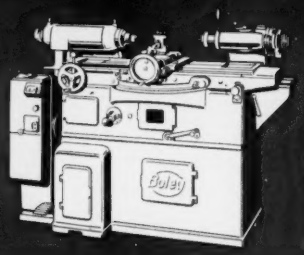
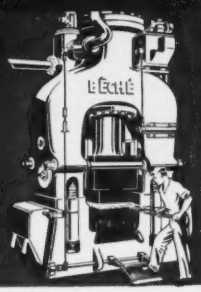
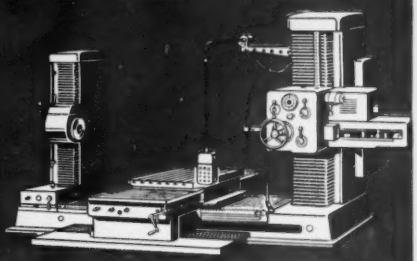
TOOLS FROM THE CONTINENT



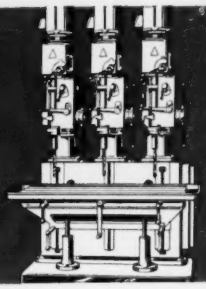
BOLEY. Precision and capstan lathes. Drilling and tapping machines.



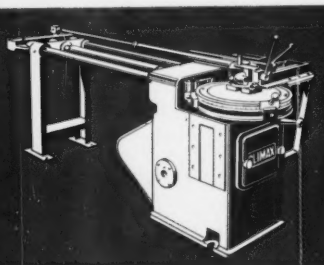
BECHE & GROHS. Hammers. Compressed air and steam.



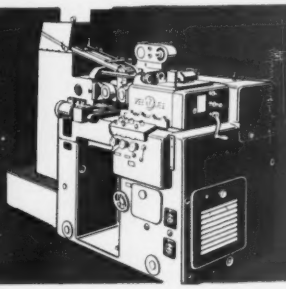
WETZEL UNION. Horizontal boring machines, 4", 5" and 6½" spindle dias.



ASBO. Drillers, table, column, box-stand, single and ganged types.



CLIMAX WERKE. Pipe bending machines up to 2½" dia. cap. in steel.



PEE WEE. Form and thread generating machines.

This summary of foremost continental manufactures is intended as a general guide which it is hoped you will find of value when considering your machine tool needs.

These machines are representative of some of the finest equipment in their respective fields. Many of the names of their makers are well known in the British metal working industry ; names which guarantee quality materials and sound engineering practice—the reliability and accuracy of the finished product. Modern trends incorporated in their design and operation will be detailed in proposals based on your production requirements. At present we can offer favourable delivery for most of these lines. We shall be pleased to quote or to send a specialist to discuss details.

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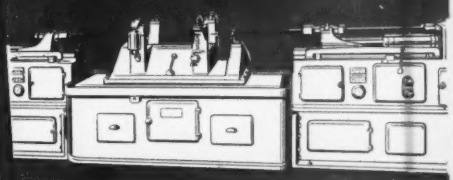
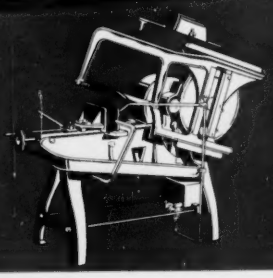
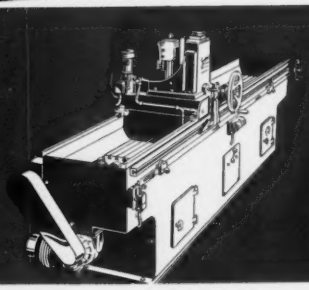


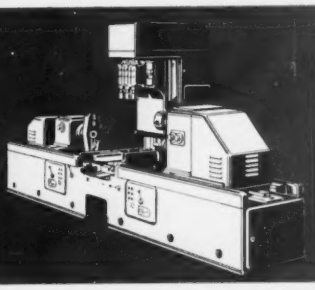
HULLER. Deep hole drilling, boring, tapping and milling machines and units.



KLAEGER. A complete range of hacksawing machines.



GOECKEL. Special grinders for straight and circular cutters and surface grinding.



LUDWIGSBURGER. Superfine boring machines and equipment.

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Design, Materials, Production Methods, and Works Equipment

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VOL. XLII No. 555 JULY 1952 PRICE 3s. 6D.

Export Trade

A CAREFUL study of a closely reasoned argument about the automobile industry from a source not directly connected with the industry can be a salutary experience. For example, in a recent issue, *The Economist* devoted a leading article to a review of "The Export Markets for Cars". It adumbrates certain arguments which the automobile industry may have to consider in the not too distant future, but this is not to say that the conclusions reached are to be accepted.

The tone of the article may be illustrated by two extracts. First :—"But to justify its claim to be the country's major currency earner, and prove its right to steel in competition with other exporters and essential users, the motor industry must develop its sales this year in two areas where the demand for its products has recently been falling—the dollar markets and the other non-sterling areas. The recent exports to these markets has not been encouraging. The main change in sales to these markets last year came in Canada, where—owing largely to restrictions upon credit sales—the shipments of British cars fell from 76,000 in 1950 to 27,000. In 1950 about 8 per cent of British car exports went to dollar markets and a little over 17 per cent to the markets in Europe and North Africa ; in 1951 these proportions had changed to 9 per cent and 15 per cent, but in the first quarter of this year only 6·6 per cent of sales went to dollar markets, while European sales increased fractionally to 15·5 per cent. In this same quarter, moreover, sales to the United States dropped by 13 per cent, to Brazil by 11 per cent, and to Canada by more than 90 per cent below the quarterly average for 1951. It might now be possible to achieve a considerable increase in exports to Canada for, since the lifting of credit restrictions there, some British manufacturers have again been shipping at the rate of 2,000 cars a month. Orders from the United States have also been reviving. But any substantial increase in sales to other markets may be hard to achieve. for these are the marginal markets where Britain is meeting increased competition—and where the industry may need new models before it can attract more customers."

In conclusion, *The Economist* states :—"All factors considered, it is not easy to be confident that the markets outside the sterling area, even assuming a major increase in sales to Canada, can be induced to take many more cars than they did last year. If these exports should not rise, the Ministry of Supply would then be entitled to divert any extra steel it finds available to other industries that could use it more profitably in defence or non-sterling exports. Whether it would do so is less certain. On the one hand, the Ministry ought to be more ready to act severely in this matter than at any time since the war, and there are certain industries—even in the metal consumer goods field—that have been fulfilling even higher export quotas than the motor industry for articles made largely from flat steel products. On the other hand, several manufacturers have new models almost ready that may strengthen their competitive ability ; a further cut in output, by increasing overhead costs per unit, would make competition even more difficult ; and already the industry as a whole is operating at only 60 per cent of its capacity, which has been doubled since the war. Moreover, if sheet steel were to become less scarce, the Ministry might not deem it practicable to refuse extra supplies to the industry that is so important a consumer. What the Ministry may in fact do—and certainly should do—is to discriminate even more severely than at present in allocating steel to different manufacturers."

Undue Pessimism

The authority of *The Economist* is such that any views on trade tendencies expressed in its editorial columns must be studied with respect. But in this case, we feel that too dark a picture has been painted. That competition will become increasingly keen has long been recognized within the industry ; the journeyings of the leaders of the industry to make personal appraisal of the needs and problems of overseas markets is proof of this. The general consensus of opinion among those in the industry who are most conversant with the problems of the export markets is that it is still possible not only to maintain but even to expand the export trade, although there is full awareness of the difficulties.

Fluctuations from market to market and, from time to time are inevitable, and there may even be at some period an overall recession, but much stronger arguments need to be advanced before a case is made out for a reduced allocation of materials to the automobile industry.

Since the war, and under very severe handicaps, the automobile industry has increased its efficiency in a ratio much in excess of the national average. Very large capital sums have been expended in re-equipping and re-tooling factories; advanced manufacturing techniques for making the best use of labour have been developed; and much time and money has been spent in developing new markets. The full fruits still remain to be garnered.

Leaders of the industry realize that the sellers' market is past and future trade must depend upon price and quality. As *The Economist* recognizes, the industry is to-day working at only 60 per cent of its capacity, with a consequent detrimental effect on prices. Any reduction in steel supplies would lead to even less effective use of manufacturing capacity, with a more than proportionate increase in unit costs. Any cut in steel supplies because of a reduction in exports, which may well only be temporary, would gravely affect the industry and have a detrimental effect on the national economy.

Later Views

In point of fact, the latest figures for the export of motor vehicles, which were issued after the foregoing was written, are distinctly encouraging. In spite of the import cuts imposed by Australia and New Zealand, the industry's two largest markets, exports have been maintained at a high level. In fact, in May of this year 32,145 cars were sent overseas, whereas the monthly average for 1951 was 30,728. Similarly, commercial vehicle exports in May of this year totalled 13,625 against a monthly average of 11,429 in 1951.

Exports to the dollar markets also show an encouraging tendency. In May of this year 3,055 cars were exported to the United States, the largest number since November, 1948, and nearly double the number shipped in May, 1951. The figures for Canada show that in May of this year 2,904 cars were shipped, a number not exceeded since June, 1951. In fact, total British exports of cars and commercial vehicles remain greater than those of any other country, including even the U.S.A. Good as these figures are, they could even be bettered if the industry could make full use of its resources.

A Production Economy

UNLESS there are fundamental developments in materials, of which at present there is no sign, there is little likelihood of any appreciable increase in rates of metal removal over those now employed in the automobile industry. In fact, any development that can be reasonably envisaged could not seriously affect manufacturing costs, since the speeds and feeds now generally employed give remarkably short cutting times. It is probably true to say that any marked increase could be obtained only at a disproportionate cost.

As cutting times are shortened, loading and unloading times take on greater significance. Frequently, the problem of reducing these times is far from simple. The component must be accurately located in its fixture and must be securely held to withstand the forces set up by the tools. Hitherto, there has been a tendency to play for safety in the design of work-holding fixtures. With such fixtures, loading and unloading were relatively difficult and took an undue proportion of the total machine cycle. To-day there is evidence of a new outlook on this problem.

There have been remarkable and encouraging developments in work-holding fixture design within the past two or three years. An obvious example is, of course, the tunnel type fixture which, in line production, allows the work to pass straight along. Concurrently with this there has also been a great simplification of fixture design. Simple, yet positive, methods of location have been devised and applied to a wide range of components. These have been important in reducing idle time, but perhaps of even greater importance has been the incorporation in work-holding fixtures of simpler clamping means.

Despite the improvements that have already been made, the problem of clamping work is certainly worthy of further study. No matter whether the clamps are to be applied hydraulically, pneumatically or manually, there are certain basic principles to be observed. When they are observed, they not only help to reduce the loading and unloading times, but also can lead to increased tool life and to a reduction in rejections due to faulty machining.

Machine tools of modern design usually are sufficiently rigid and have sufficient power to take full advantage of the properties of the available cutting materials. At the speeds and feeds which are now common practice, chatter must be avoided if the optimum results are to be obtained. It is a fair assumption that the machine spindle will be free from chatter and, therefore, if it does occur, the fault will usually lie in the work-holding fixture. If there is chatter, the results will be shortened tool life, the production of inferior work and eventually the machine itself will be affected.

The necessity for freedom from chatter still leads some engineers to design needlessly elaborate work-holding fixtures. This is to take the line of least resistance. What is required is a qualitative analysis of the forces that will be operating on the work during the cutting cycle. Where the trouble is taken to consider this aspect of the problem, it will usually be found that the fixtures are sufficiently open to allow the shortest possible loading and unloading times and at the same time give the freedom from chatter that is necessary for maximum tool life and high quality work.

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THE LEA-FRANCIS CHASSIS

A Unit Designed for the 18 h.p. Saloon and 2½-litre Sports Models

AFTER the war, while the new Lea-Francis engine was being prepared, the chassis design was modified to conform with modern developments and to suit the new power unit. Nearly all the chassis components are common to the whole range of models now being produced by this manufacturer, the principal exceptions being the engine and rear axle. The range includes :—

14 h.p. 4-light saloon
14 h.p. estate car
18 h.p. 6-light saloon
2½-litre sports

The 14 h.p. models are powered by an engine of earlier design, with bore and stroke of 75 mm and 100 mm respectively. It is used in conjunction with a spiral bevel rear axle. The other two vehicles incorporate a hypoid axle in conjunction with the 2½-litre engine, bore and stroke 80 mm and 110 mm, described in the June issue of the *Automobile Engineer*. Even the torsion bars employed in the independent front suspension unit are identical, the appropriate static deflection being obtained, in each case, by an adjustment of the initial setting of the bar.

When production is on a small scale it is not possible to make frequent sweeping changes either in style, or in mechanical features, and the alterations that are made have to be limited to those necessary to bring the design up to date. However, this is not such a serious disadvantage to the manufacturer as might at first appear, for while it is necessary for the producer of hundreds of thousands of cars to redesign completely his models before the public become tired of seeing them, there is no reason why the manufacturer of only hundreds of cars should make changes just for the sake of a change. After all, his customers are those who expect the quality and reliability of a hand-built vehicle of a well-tried design, and the fact that it is hand-built, as opposed to mass produced, ensures that it will possess a measure of individuality.

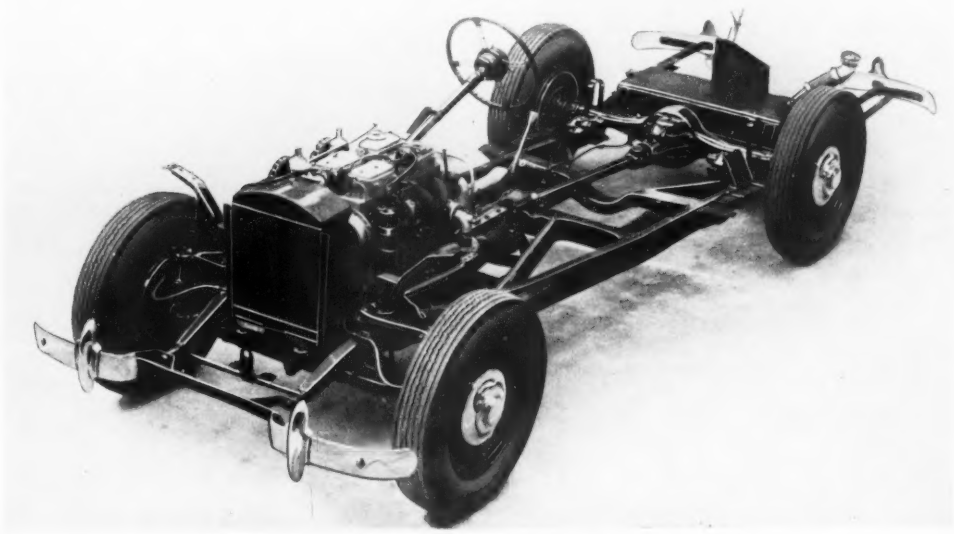
SPECIFICATION

TRANSMISSION: Unit construction gearbox, four forward speeds and reverse. Ratios: top 1·00:1, third 1·419:1, second 2·135:1, first 3·452:1 and reverse 2·982:1. Hardy Spicer propeller shaft with needle roller bearings.
REAR AXLE: Semi-floating. Hypoid bevel drive with four-pinion differential. Ratio: 3·916:1 in the 18 h.p. model and 3·64:1 in the sports version.
FRONT SUSPENSION: Torsion bar and transverse wishbone.
REAR SUSPENSION: Semi-elliptic.
SHOCK ABSORBERS: Girling lever type.
STEERING: Recirculatory ball unit, 3½ turns from lock to lock.
BRAKES: Girling hydraulic, 12 in diameter × 2⅜ in wide.
TYRES: 6·00 - 16·00.
DIMENSIONS: Wheelbase 9 ft 3 in (18 h.p.) and 8 ft 3 in (sports). Track, front 4 ft 4⅛ in, rear 4 ft 4⅜ in.

Clutch

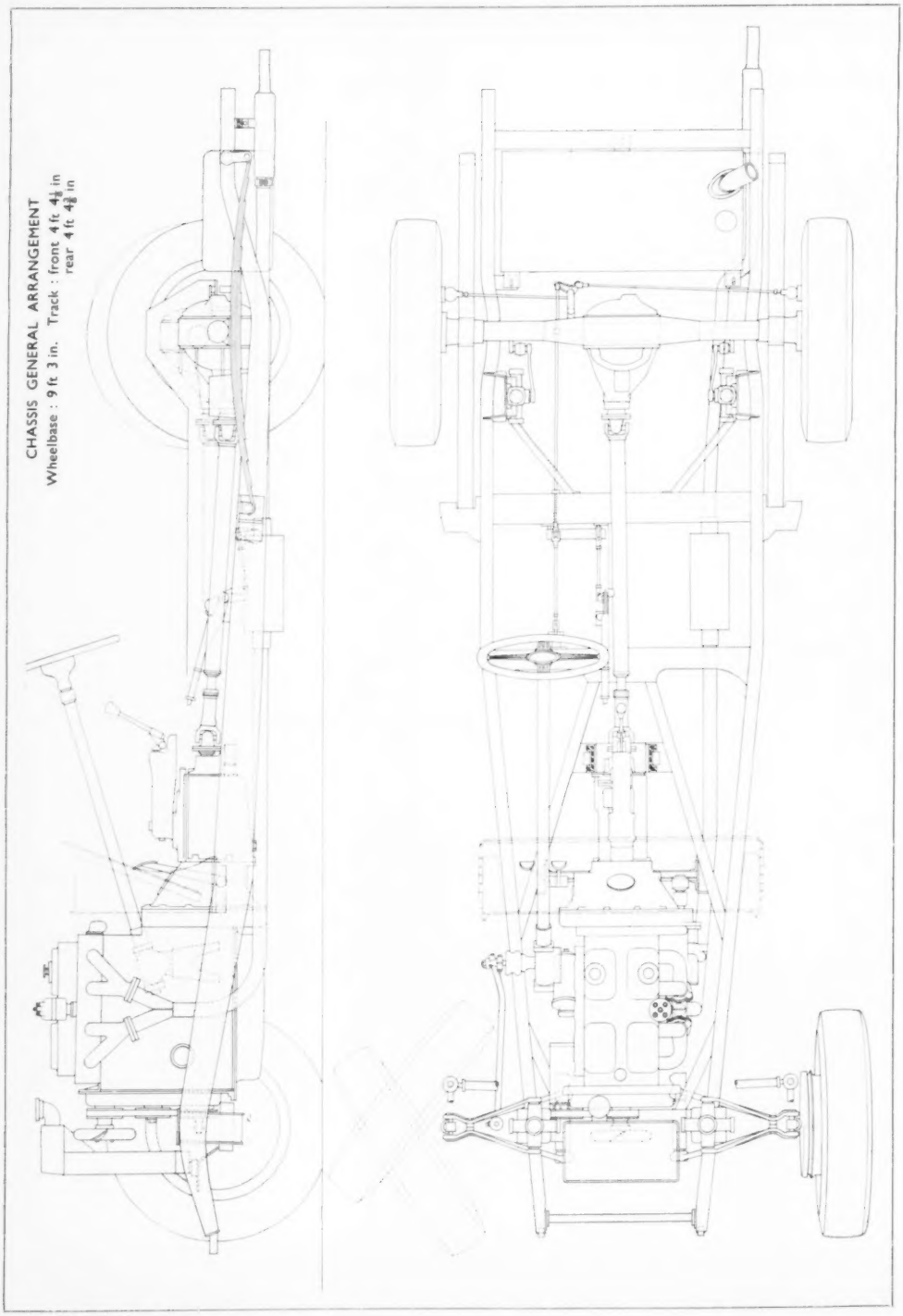
A 9 in diameter, single dry plate, Borg and Beck clutch, with a spring-type centre plate, is fitted. A heavy pressure plate ensures rapid dissipation of heat generated by clutch engagement at high engine speed. Nine thrust springs apply pressure directly to the plate. The end coils are seated on raised bosses to ensure adequate air circulation around them, thus guarding against loss of temper due to overheating.

Three equally spaced lugs cast integrally with the pressure plate project through slots in the wall of the cover. This is a positive and accurate method of centring the plate in relation to the cover, as well as being a simple means of driving it. The lugs are machined in the form of a hook, and in each is engaged the outer end of the



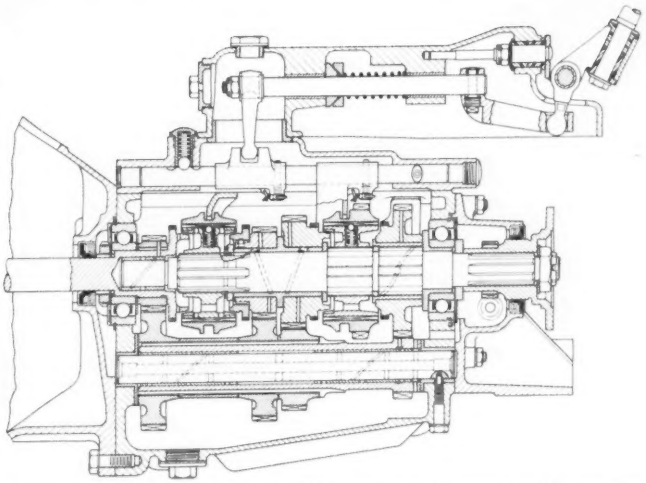
The Lea-Francis chassis. Most of the components are common to all models

CHASSIS GENERAL ARRANGEMENT
Wheelbase : 9 ft 3 in. Track : front 4 ft 4½ in
rear 4 ft 4½ in



pressed steel release lever. The levers are mounted on pins carried in adjustable eyebolts on the clutch cover. A forward dowel-extension of the eyebolt registers in a drilled hole in the rear face of the pressure plate, and acts as a guide for the alignment of the levers.

A carbon thrust ring is employed for the clutch disengagement control. The clutch pedal is pivoted on a short bolt supported, at one end by a lug on a cross member for the torsion bars, and at the other end by a bracket, carrying the cross member, on a diagonal bracing member. An adjustable horizontal rod connects a boss on the pedal stem, above the fulcrum bolt, to the clutch operating lever, and allows a certain amount of torsional vibration to take place without appreciably affecting the clutch control operation.



A noteworthy feature of the Armstrong Siddeley gearbox is the constant mesh bottom gear

Gearbox

Four forward speeds and reverse are available with the Armstrong Siddeley gearbox. It is adapted for the Lea-Francis vehicles by fitting a remote control unit on the top cover. The clutch housing is different from the standard Armstrong Siddeley version, and so is the pedal arrangement. In addition, a special rear cover, incorporating the engine mounting brackets, is fitted. Second, third and top gears are synchromesh, and the gear ratios obtained are: top 1·00:1; third 1·419:1; second 2·135:1; first 3·452:1; and reverse 2·982:1. The oil capacity of the box is 3½ pints. Although the box is of cast iron, the top and rear covers, and the clutch bell-housing, are of cast aluminium.

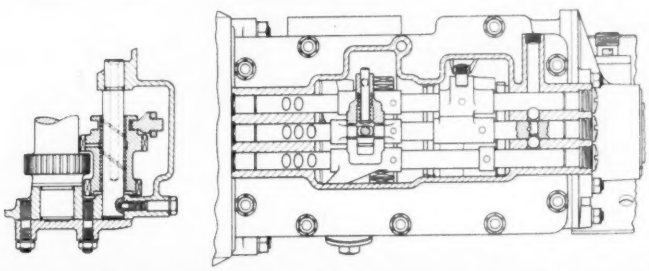
Mounted in the rear of the bell-housing is a lip-type oil seal, supplied by G. Weston and Co. Ltd. It bears on the 1 in diameter primary shaft, of case hardened En 34. The oil hardened En 24Z, helical driving pinion is not integral with the shaft but is splined on as, at the rear end, there is a flange larger in diameter than the gear, and this would make it impossible to cut the teeth if the gear were integral. Machined on the rear of the flange is the synchromesh cone and, around its outer periphery, are the teeth for engaging the internal splines in the sliding member.

This member, with its B8 phosphor bronze cone, engages third or fourth gear. It is held in the neutral position by the usual arrangement of six spring-loaded balls that provides the necessary pre-determined load to engage the cones. The centre member of the clutch assembly is splined to the En 19U, or Vibrac V30 mainshaft, the front end of which is carried in a fully floating bush in the end of the primary shaft. On the inner periphery of the bush is a helical groove, and in addition the bush has twelve $\frac{1}{8}$ in diameter holes drilled through its walls to assist lubrication.

Ultimately the bearing load at this end, from both the shafts, is carried in a ball bearing around the 35 mm diameter portion of the input shaft. The inner race of this bearing, with a chip shield on each side, is clamped between a ring nut and the boss of the pinion. A tab washer locks this nut. It has two internal tabs, diametrically opposite one another on a vertical line through the centre of the washer, engaging in longitudinal slots in the threaded portion of the shaft. Axial location is effected by a circlip in a groove around the outer race of the bearing. This circlip is clamped, together with suitable shims, between the clutch bell-housing and the front wall of the box.

To the rear of the synchromesh assembly, around the 1·225 in diameter part of the mainshaft, is a heavy bearing bush with a central flange, made up of three pieces. This bush, as well as all the others, is made of B8 phosphor bronze. Helical grooves, around the bearing surfaces, assist lubrication. In front of the flange is the oil hardened En 24Z, third-speed helical gear which carries, splined on a forward extending boss, the integral synchromesh cone and toothed ring. To the rear of the flange is the helical second-speed gear, of the same material, which is machined integrally with the synchromesh cone and toothed ring. The whole assembly on the bush is held between two heavy thrust washers; the one at the rear bears against a shoulder on the shaft, while the internally splined one at the front is located by a tab washer and circlip in a groove around the splines on the shaft.

Behind the second-speed gear is the synchromesh sliding assembly. This is similar to that for top and third speeds except that reverse-gear teeth are machined on the outer member, and there is, of course, no cone at the rear. The case hardened En 34 first gear is carried on an internally splined, flanged bush which is prevented from



A sliding pinion engages reverse gear (left). A spring-loaded ball registers in a groove under the reverse bias plunger (right)

moving forward by a divided collar in a groove around the shaft. The two parts of the collar are retained in a recess in the bore at the front end of the bush. A helical groove is machined around the bush for lubrication.

The inner race of the rear ball bearing is carried on a case hardened, En 32, flanged distance sleeve on the mainshaft. This sleeve positions the first gear, and acts as a chip shield. End location is effected by a circlip in a groove around the outer race which is housed in the rear wall of the box. The circlip is retained in position, in an annular recess in the rear face of the housing, by a spigot on the rear cover, suitable shims being fitted. Carried in this cover is a lip-type oil seal. It bears on the boss of the universal joint flange splined on the 1 in diameter tail end of the mainshaft. A split-pinned, castellated nut on the end of the shaft pulls the whole assembly, at the tail end, against a $\frac{1}{4}$ in thick, distance washer that bears on the inner race of the ball bearing.

Location of the $\frac{7}{8}$ in diameter, case hardened layshaft, of En 32, is effected by a dowel-ended bolt screwed through the bottom of the casing at the rear end, the dowel engaging in a radial hole in the shaft. At both ends, it is supported in bosses in the casing. The shaft is drilled axially, and at each end it is tapped to receive a $\frac{3}{8}$ in threaded extractor. Oil is fed, through a suitably placed passage between the rear wall of the bell-housing and the front wall of the box, into the front end of the drilling.

A longitudinal groove is cut along the layshaft, and connecting this with the axial drilling, are radial ducts to

The crown wheel is bolted to the inner face of a flange around the differential cage

distribute oil to the two bushes that carry the case-hardened sleeve for the layshaft cluster. Positioned one at each end, these bushes are each $3\frac{1}{8}$ in long. Axial thrust is taken by Bi-metal washers.

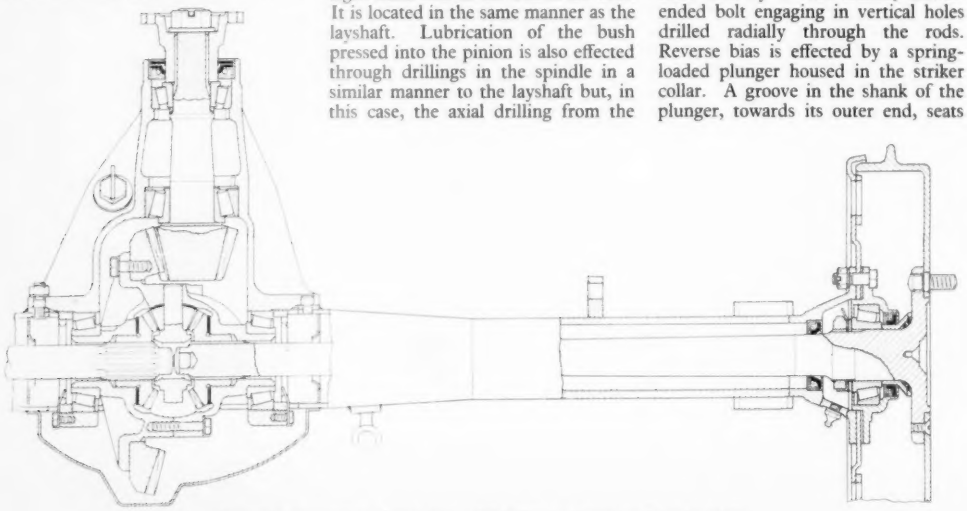
Integral with the En 34 sleeve is the bottom gear. This, and the remainder of the first speed and reverse train are the only straight-toothed gears in the box. Assembled on the splines at the front of the sleeve are, from front to rear, the layshaft gear, a distance sleeve, third and second gears. All the gears are made of En 24Z and are oil hardened. They are located by a shoulder behind the second gear. The splines are carried through the shoulder to simplify the machining operation.

The $\frac{11}{16}$ in diameter En 16T spindle for the case hardened, En 34, reverse pinion is carried in two bosses in the right-hand side of the box at the rear. It is located in the same manner as the layshaft. Lubrication of the bush pressed into the pinion is also effected through drillings in the spindle in a similar manner to the layshaft but, in this case, the axial drilling from the rear of the spindle terminates about $1\frac{1}{8}$ in from the front end, and it is fed with oil from within the box.

Three selector rods are carried, all on the same horizontal plane, in bosses at the front and rear of the top cover. Pressed steel, domed plugs seal the front ends of the front bosses, while the rear ends of those at the back are sealed by screwed-in plugs, so that the rods may be withdrawn when necessary. The gear locks are spring-loaded balls in bosses above the front end, where they engage in notches on top of the rods.

Drilled transversely through the centre rod, towards the rear, is a hole in which there is a plunger. This, in conjunction with a ball at each end of it, in the housing, ensures that only one rod at a time can be moved, there being notches on the two side rods into which the balls can move. The axis of the plunger, and the centres of the balls and of the notches are, in the neutral position, all in one straight line. When one of the side rods is struck, it unseats its ball from the notch, and pushes it partly into the drilling in which is the plunger. This forces the other ball into its groove in the rod at the other side. If the centre rod is struck, it forces both balls into the grooves in each side rod. A peg, vertically placed in the shaft, engages in a flat on the periphery of the plunger to prevent it from accidentally falling out when the rod is withdrawn for servicing.

The integral selector forks and collars, and the striker and stop collars are aluminium-bronze die castings. They are each located on their rod by a wire-locked, dowel-ended bolt engaging in vertical holes drilled radially through the rods. Reverse bias is effected by a spring-loaded plunger housed in the striker collar. A groove in the shank of the plunger, towards its outer end, seats



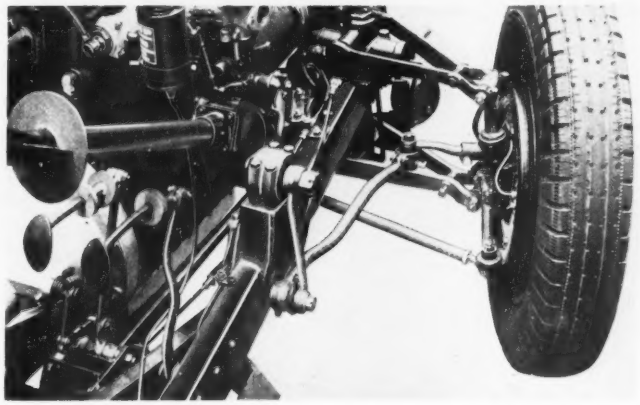
General arrangement of rear axle. Oil baffles are fitted in the axle tubes

a spring-loaded ball giving a positive reaction to avoid accidental engagement of reverse. When reverse gear is struck, the ball rides out of its groove and the plunger is forced back against its spring.

An aluminium casting on top of the box houses the remote control mechanism. It is held in position by the four $\frac{19}{16}$ in diameter studs that, in other vehicles, secure the control tower. Keyed on to the front end of the horizontal control rod is the boss of the front striker lever. It is pulled up against a shoulder on the rod by a self-locking nut. Two phosphor bronze bushes, pressed into bosses which are $2\frac{1}{2}$ in apart in the casing, carry the $\frac{5}{8}$ in diameter rod. The front bush is $1\frac{3}{8}$ in long. Bearing against its rear face is a seal, the rear of which is coned so that it may be retained by an internally chamfered washer. Between the rear face of the washer and the front of the rear bearing boss, is a compression spring.

A lever is secured to the rear end of the rod. Its major axis is in the vertical plane, and it is cranked to the rear. Fitted in the boss of the lever is a screw, one end of which is squared for a spanner, and at the other end is a dowel extending into a diametrically drilled hole in the rod. At the rear end of the lever is an eye in which is registered a ball-end, screwed into the bottom of the rear striker lever. On the top end of the striker lever is a boss carrying the gear shift control. This control is mounted in a divided rubber bush, each end of which is flanged to bear against retaining washers. The upper washer bears against a shoulder on the gear shift lever. Screwed into the bottom end of this is a set bolt to pull up the lower washer that retains the whole assembly in its boss.

Approximately mid-way between the two ends of the striker lever is another boss. Pressed into it is a phosphor bronze bush for the $\frac{1}{2}$ in diameter fulcrum bolt secured by a self-locking nut. This bolt is carried by a forked eye-bolt, the shank of which is supported in a divided rubber bush in the housing. The eye-bolt is secured by a self-locking nut and retaining washer. A forward plain extension of the shank, engaged in a hole drilled in the housing, furnishes additional support to this bolt. By making use of rubber bushes in this way, there is no possibility of annoyance due to rattling joints.



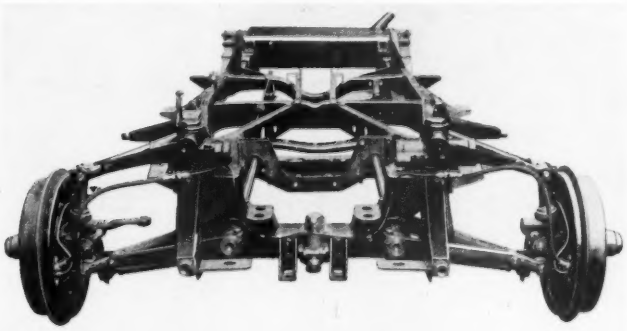
The steering box is mounted on a bracket on the side frame

Rear axle

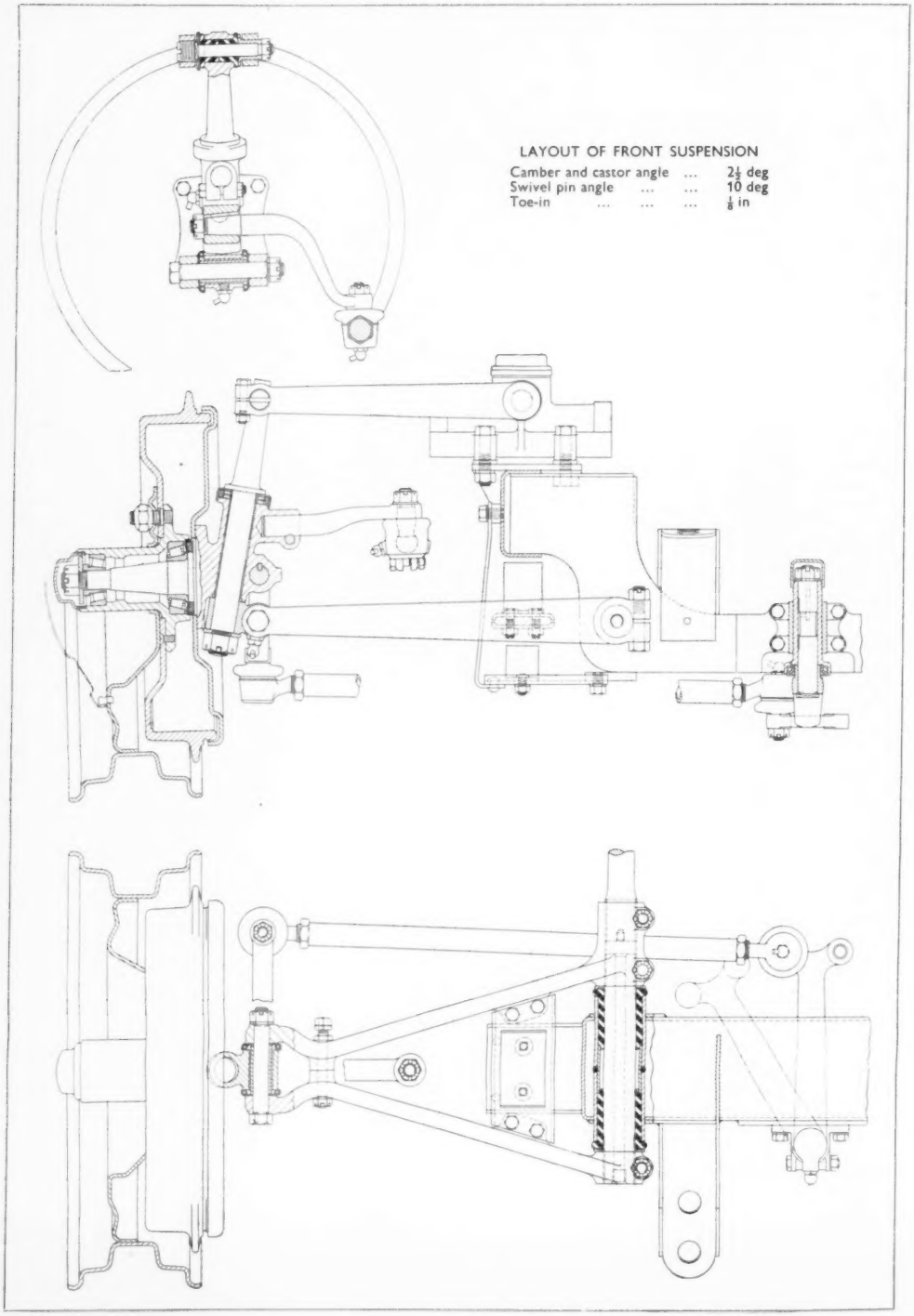
A Hardy Spicer propeller shaft, $2\frac{3}{4}$ in diameter on the saloon and $2\frac{1}{4}$ in diameter on the sports version, carries the drive to the semi-floating rear axle. Its length, in the saloon car, is approximately 49 in between the centres of its needle roller bearing universal joints, but in the sports version, it is only 37 in. The axle ratios are 3·916:1 in the saloon, and 3·64:1 in the sports model. A banjo-type casing, with a welded-on rear cover, houses the four-pinion differential unit.

The malleable cast iron nose-piece is secured to the banjo casing by ten $\frac{3}{8}$ in studs, and it is positively located by two dowels. Ribs are furnished on each side for lateral support, and on the left-hand side a filler plug is screwed into a boss above the rib. The twelve-tooth, hypoid pinion is integral with its shaft, the axis of which is offset $\frac{5}{8}$ in to the right of the plane in which are the axes of the differential pinions, and $1\frac{1}{4}$ in below the axis of the crown wheel. The shaft is supported on two taper roller bearings positioned about $2\frac{3}{8}$ in apart. At the rear, the inner race is mounted on the $1\frac{1}{2}$ in diameter portion of the shaft, and bears against the front face of the pinion. Axial location is effected by shims, between the front face of the outer race and a flange inside the nose-piece in which it is housed. The inner race of the front bearing is mounted on a $1\frac{1}{4}$ in diameter portion of the shaft. Between the rear of the inner race and a collar machined on the shaft, is a distance washer that controls the pre-load on the bearings. The rear of the outer race bears against another flange inside the housing. A split-pinned, slotted nut pulls the internally splined boss of the flange for the universal joint against the inner race. Housed in the front end of the nose-piece, and bearing on the boss, is a Gits oil seal.

There are forty-seven teeth, $1\frac{1}{2}$ in long, on the $8\frac{3}{4}$ in diameter crown wheel. It is spigoted to the inner face of a flange around the differential cage and secured by ten $\frac{3}{8}$ in diameter bolts, locked by tab washers. Webs extended outwards, between the flange and the cage, give added stiffness.



A bolted-on cross member supports the rear end of the torsion bars



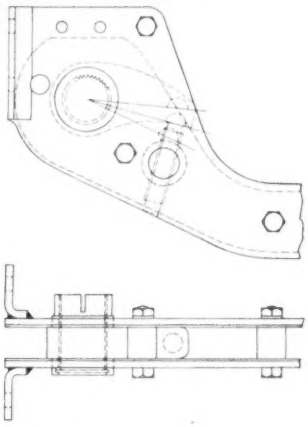
LAYOUT OF FRONT SUSPENSION

Camber and castor angle	...	2½ deg
Swivel pin angle	... ...	10 deg
Toe-in	... ...	⅛ in

The cage is split on the plane of the axes of the spider arms, and the two parts are held together by eight $\frac{7}{16}$ in diameter bolts locked by tab washers. Each of the four differential pinions has a spherical outer face bearing on a phosphor bronze thrust washer in the cage. Flat phosphor bronze thrust washers are interposed between the outer face of the differential gears and the cage, in which the bosses for these gears are carried. Around the cage on each side, is a taper roller bearing carrying it in the nose-piece. The mesh of the crown wheel, as well as the pre-load of the bearings, is governed by ring nuts pulled up against the outer races. Locking plates, secured by set bolts to the nose-piece, engage these nuts.

Hardened plugs, pressed in the drilled inner ends of the $1\frac{1}{8}$ in diameter half-shafts, are spaced with their end faces 0·002-0·004 in apart at the centre of the spider which is drilled to clear them. Formed integrally with the outer end is the wheel hub. In order to avoid weakening the half-shafts, the root diameter at the splines, on which are mounted the differential gears, is the same as the outside diameter of the rest of the shaft. The axle tube is fabricated from three parts butt-welded together. The inner portion, having a wall thickness of $\frac{5}{32}$ in, is tapered from $3\frac{1}{4}$ in diameter to $2\frac{5}{8}$ in diameter over a length of about 5in. In it is welded a baffle plate to prevent oil passing to the wheel hubs. Outboard of this part, the tube is parallel, with a wall thickness of about $\frac{1}{4}$ in. On its extreme outer end is butt-welded the brake back-plate carrier. Housed in this is a Gits oil seal bearing on the wheel hub.

Assembled on the hub, before the half shaft is inserted into the axle tube, is the wheel and brake assembly. At the outer end of the hub is a flange on which is spigoted the brake drum secured by countersunk set screws. Bearing against the inner face of the flange is the coned end of a distance tube. A rubber ring, around the fillet between the hub and its flange, forms an oil seal. Slots, through which the ring may be centred on assembly, are provided in the cone. Against the other end of the sleeve is the inner race of a taper roller bearing. It is pulled up by a ring nut, locked by a tab washer. The outer race of the bearing is carried in a flanged housing which is bolted, together with the brake back plate and a joint washer, to the flange of the carrier on the axle tube. In the outer end of the bearing housing, is a Gits oil seal around the parallel portion of the coned distance sleeve.



Detail of the adjustable stop and carrier for the torsion bar

Rear suspension

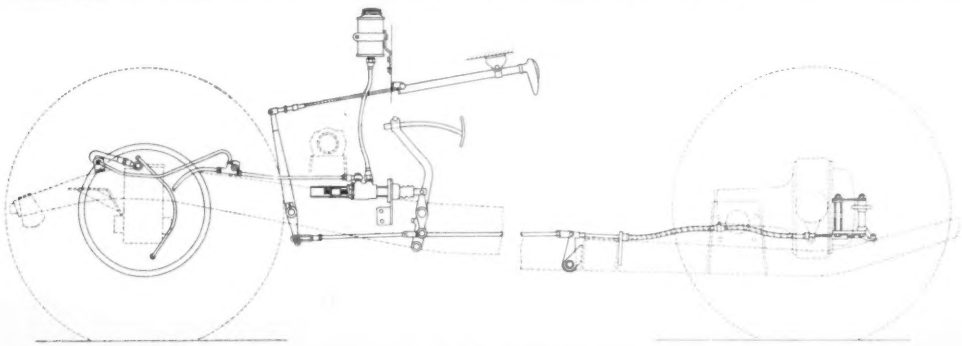
In order to clear the underslung chassis frame side members, reverse camber semi-elliptic springs, 44 in long, are used at the rear. An arrangement of this type has an inherent under-steering tendency, so the axle is mounted in the centre of the spring, the pressed steel pad for the spring being welded to the axle tube. Seven leaves, $\frac{3}{16}$ in thick by 2 in wide, are employed. From bump to rebound, the deflection is $7\frac{1}{2}$ in and, to the three-quarters laden position, it is 3 in. The spring rate is 97 lb/in, giving a periodicity of 71 cycles/min.

The rear shackle is carried on a trunnion mounting, overhung from the outer face of the frame side member. This member is reinforced internally by a welded-in bracket and a distance tube. Further support is afforded by the rear frame cross member, which is positioned just behind the mounting. At the front there is an out-rigger bracket which, as well as carrying the spring eye, serves as a body mounting point. This bracket, fabricated from $\frac{1}{4}$ in plate, consists of two right angle pieces placed back-to-back to form a T-shape, the two arms of which are riveted to the outer face of the frame side member. Welded over the top of the T, on the edges of the angle plates, is a flat plate, Under this, to the rear of the centre web of the T, is riveted a small right angle bracket that supports the outer end of the pivot bolt for the spring eye. The inner end of the bolt is screwed into a $\frac{3}{4}$ in B.S.F. tapped boss welded to the bracket, and projecting through a clearance hole in the frame side member.

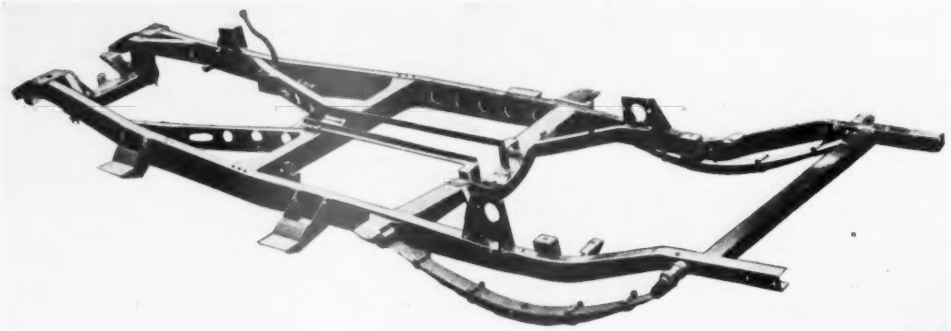
Front suspension and steering

Torsion bar and wishbone front suspension units are employed. The static deflection is 3 in, for a load of 650 lb, and there is an equal amount of additional travel to full bump. Camber and castor angles are each $2\frac{1}{2}$ deg, and the toe-in is $\frac{1}{8}$ in. The swivel pin angle is 9 deg.

The shot-peened En 20 torsion bars are $22\frac{1}{2}$ in long by 1·035 in diameter. They are oil hardened from 900 deg C and tempered from 300 deg C, also in oil. To the static position, the angular deflection is 8·8 deg, and there is a further 10 deg travel to



In the saloon version a pistol-grip hand-brake control is fitted



Apart from the front cross member, the frame is built up entirely of channel section members

full bump. The maximum stress is 101,600 lb in^2. Splined on the rear end of each torsion bar is a lever. The boss of this lever is carried in the two plates that are bolted together to form a cross member under the back of the clutch housing. Also between these plates, is a block in which there is a ball-ended adjusting screw that seats in a cup-end on the lever to set the static position of the suspension unit.

Splined on the front end of the torsion bar, is the two-piece forged wishbone of En 32. It is secured by pinch bolts, two in the boss on the end of the rear arm, and one in the shorter boss on the front arm. The root diameter of the 80 deg straight flanked splines is greater than that of the working section of the bar. The two wishbone arms are held together by a bolt through the junction near their outer end, and by a bump and rebound stop bolted on between both arms about 4$\frac{3}{4}$ in from the axis of the inner bearing. This stop consists of two shallow channel-section members bolted, with their flanges together, to a lug on the inner face of each wishbone arm. Mounted on top of the stop is the bump rubber. The rebound rubber is mounted on another shallow channel-section member extending outwards from below the frame cross member, and supported by two steel straps bolted to the platform for the lever type shock absorber.

Between the two arms of the lower wishbone is a rubber bush assembly, forming the inner bearing, around the torsion bar. Its tubular housing is welded to the front cross member. In it are two Harrisflex rubber bushes separated by a tubular distance piece that is retained by tack welds in two drilled holes in the outer tube. The outer ends of the parallel rubber bushes bulge, on being compressed, to form flanges, which are held in pressed steel retaining washers.

The outer end of the wishbone is positively located in a phosphor bronze bearing. The En 21 bearing bolt is secured by a split-pinned, slotted nut. Around it is a steel sleeve forming a distance piece between the bosses of the two parts of the wishbone arm assembly. The flanged phosphor bronze bush around the distance tube is split, at right angles to its axis, into halves. Rubber sealing rings are positioned around the flanges and held by dished retaining washers. The bearing is housed in a boss mounted on the lower end of the swivel pin.

Splined on the spindle of the Girling piston-type damper are the En 20 upper wishbone arms. They are clamped together, near their outer ends, by a $\frac{3}{8}$ in diameter bolt with a slotted nut. Adjustment to the castor angle is effected at the bearing. Here, the boss of the rear arm of the wishbone is carried on an En 5 flanged bush on the fulcrum pin. Its axial position on the bush, and therefore the castor angle, is controlled by the front wishbone arm into which is screwed the other end of the pin which, at this point, is $\frac{5}{8}$ in diameter. When the adjustment has been made, with a screwdriver in a slot in the end of the pin, the arm is locked by a pinch bolt clamping the split boss around the thread. Immediately to the rear of the shoulder of the screwed portion of the pin is a retaining washer. Between this and the flange of the rear bush is a flanged Harrisflex rubber bush, split transversely into two parts. It is carried in a boss at the upper end of a pedestal extension of the swivel pin.

The En 32 swivel pin is carried in phosphor bronze bearings in the En 21 stub axle forging. Below its upper pedestal extension is a flange, under which is a dished retaining washer for a felt seal around the two thrust bearing washers. These are each $\frac{5}{32}$ in thick, the upper one being of case-hardened steel, while the lower one is of bronze. The diameter of the pin below the flange is $\frac{15}{16}$ in, and the length of each of the phosphor bronze bushes supporting it, is 1$\frac{1}{2}$ in. They are spaced $\frac{1}{4}$ in apart. At the bottom end of the lower bush, in a recess in the forging around the pin, is a cork seal. Bearing against this is a small En 21 forged boss carrying the bearing for the lower wishbone arm. A grease nipple is provided to lubricate the bearing. The boss is retained by a split-pinned, slotted nut with a plain washer on the $\frac{3}{4}$ in diameter threaded lower end of the swivel pin.

Two taper roller bearings carry the wheel hub on the stub axle. At the inner end, a felt seal housed in the hub, and bearing on a collar machined around the stub axle, prevents grease from leaking into the brake drum. Against the collar is the inner race of the bearing, carried on the 1 $\frac{5}{16}$ in diameter part of the axle. The outer face of the outer race bears against a shoulder in its housing in the hub. The inner race of the other bearing is pulled onto the $\frac{3}{4}$ in diameter end of the hub by a $\frac{5}{8}$ in split-pinned, slotted nut. The outer race is housed in the outer end of the hub, and holds it on the axle. Interposed between the bearing and the nut is a $\frac{3}{16}$ in thick washer of such a diameter that, should the bearing fail, the wheel will not fall off.

The brake drum is spigot mounted on a flange around the hub, and it is secured by countersunk set screws. Studs, of $\frac{1}{2}$ in diameter, are screwed into the flange to carry the spherical-ended nuts for the wheels. The brake back plate, spigoted onto a flange around the stub axle, is secured by four $\frac{5}{16}$ in diameter bolts.

An En 21 steering arm is employed. At its outer end, it is carried in a boss in the stub axle forging and secured by a $\frac{3}{8}$ in diameter cotter pin. An adjust-

able ball joint is fitted in a boss at its inner end. The steering rod extends back to the drop arm splined on the spindle of the recirculatory ball steering unit. The tapered end of the track rod arm is keyed into a boss on the stub axle forging. It is secured by a $\frac{1}{2}$ in split-pinned, slotted nut. At its rear end is another ball joint for the adjustable track rod. This rod is divided in the middle where it is attached to ball joints on an En 21 idler lever.

A case-hardened En 5 pivot pin for this lever is supported by a malleable cast iron fitting bolted to the front face of the frame cross-member. The pin has a domed head at its lower end and it is carried in a phosphor bronze bush. Between the domed head and the bush is the boss of the lever. Around this boss is a Super oil seal housed in the end of the bush. At the upper end of the pin is a $\frac{1}{2}$ in split-pinned, slotted nut. A pressed steel cap, carrying a grease nipple, is fitted over the nut and screwed onto the bush to form a grease seal. The grease passes down an axial drilling and out, through a radial one, to a wide annular groove around the spindle in the bush. It is spread along the bearing surface by a flat, above and below the groove, on the spindle. The whole assembly is clamped in the casting by a pinch bolt, so that adjustment can be made to the geometry. All joints in the steering system are lubricated through grease nipples.

Brakes

In the earlier models, the Girling hydro-mechanical system was used, but the later ones have Girling hydraulic brakes front and rear. Twelve inch diameter brake drums are employed with both systems. With the hydro-mechanical layout, the brake lining widths are $2\frac{1}{4}$ in front and $1\frac{3}{4}$ in rear, but with the other system, the width of all the brake linings is $1\frac{3}{8}$ in.

The principal difference between the sports and saloon models is that the latter has a pistol-grip operated hand-brake, under the dash, whereas the sports version employs a lever-type control on the floor. The master cylinder is mounted on a bracket on the chassis side frame above and forward of the brake pedal fulcrum. The hand-brake rods are connected below the fulcrum. In the saloon version a forward extending rod has a slotted adjustable end-fitting, connected to a lever pivot-mounted on the inner face of the side frame, in front of the master cylinder. The pistol-grip control is connected to the other end of this lever, the ratio of which is 10·5:2·75. From the rear of the attachment point on the pedal, the rod is carried to an upstanding idler lever on the frame cross member immediately in front of the axle. From here, a Bowden cable carries the control motion to a swinging compensator unit mounted on a lug welded to the rear of the axle tube. In the sports model, the hand-lever, situated alongside the propeller shaft on the floor, is connected by a rod, with adjustable fork-ends, to a lever on the inner end of a cross tube mounted on the frame cross member in front of the axle. On the outer end of the cross tube is another lever connected to the rear of which is the Bowden control to the compensator on the axle. Extending forwards from this lever is an adjustable rod connected to the pedal.

Frame

Apart from some reinforcement, the frame is little changed, as can be seen from the illustration, from that used for earlier models with leaf spring and through axle front suspension. Nearly all the frame members are of 10 s.w.g. Tormac steel. Channel-section side members are employed. They are braced by a box-section cross member at the front, and by three other cross members of channel-section, two at the centre and one at the rear. In front of the forward channel-section member, the flanges of which face forward, the side members are not reinforced. To the rear, however, they are closed by another channel welded on to form a box-section.

Brackets for the lever-type rear shock absorbers are welded to the side frames, and they are each supported by a channel-section gusset braced to the cross member adjacent to the front end of the rear spring. This member is welded onto the side frames with its flanges downwards, and it is swept down at the centre to clear the propeller shaft. The front box-section cross member carries the independent front suspension and, to clear the engine sump, is also cranked down at the centre. Brackets, extending forward from it, carry the radiator, and on each side there is a platform for the shock absorbers. About $19\frac{1}{2}$ in to the rear of the front cross member, a bracket for the steering box is welded on the side frame. A channel-section bracing member on each side of the frame is gusseted from the front cross member to the point of attachment of this bracket where it reinforces the frame. It is then carried on diagonally to the rear, approximately to the centre of the second cross member, into the channel-section of which it is riveted.

For the sports version, 12 in is cut out from the side members between the centre two cross members, the joint being reinforced by a channel, welded inside. The dimensions of the members are: side members $1\frac{5}{8}$ in wide by 5 in maximum depth; front cross member 4 in square; second cross member $3\frac{3}{8}$ in deep by $2\frac{1}{4}$ in flanges; third cross member $3\frac{3}{4}$ in wide by $1\frac{3}{4}$ in flanges; rear cross member $2\frac{3}{8}$ in wide over the flanges by $1\frac{1}{2}$ in deep. These, except where otherwise stated, are minimum dimensions, the overall dimensions of the flanges on the cross members being increased, where they are attached to other parts of the frame.

Electrical equipment

Lucas electrical components are used throughout. A C45 PV5 dynamo is used, in conjunction with an RF95/2 constant voltage control unit with a positive earth, to charge the 12 volt GWT 11A/2 battery of 63 amp-hr capacity. The electrical system is protected by two 25 amp fuses. There are 10 teeth on the M45G starter pinion, and 138 on the flywheel. F700 head lamps are employed. Mounted on the dash is a B12 coil serving the DVXH 4A distributor with a centrifugal and suction-operated advance and retard unit.

Fencing of Press Brakes

THE Joint Standing Committee on Safety in the Use of Power Presses has recently published a report on safety in the use of press brakes. The provision of effective guards at the tools of press brakes has long been a difficult technical problem and the Committee was asked by H.M. Chief Inspector of Factories to review the position and make recommendations. A sub-committee composed of members familiar with the use of press brakes was appointed and their conclusions are now published.

This report, the third on the subject issued in the past five years, illustrates and describes a number of safety devices which have been developed largely by users of press brakes. The Committee lays great emphasis on the importance of maintaining in efficient condition parts of machines such as brakes and clutches.

The Committee concludes that there is now a sufficient body of information and experience available to users of these machines to enable them to adopt a safety device appropriate to the work being done.

Copies of the report, *Fencing of Press Brakes*, are obtainable from H.M. Stationery Office or through any bookseller, price 1s. 3d. net. (2016)

KRAUSS-MAFFEI KMD6 ENGINE

A Loop-Scavenged, Two-Stroke Cycle Diesel Unit

By Prof. Dr.-Ing. F. Sass, Germany, and Prof. P. H. Schweitzer, ME, Dr. Eng., U.S.A.

The Krauss-Maffei Company in Germany placed two of their type KMD6 engines at the disposal of the authors for testing purposes. They were subjected to thorough laboratory and road tests that were witnessed continuously by experts other than those in the employ of the manufacturer. The engines passed the rigid tests with outstanding success. A description of the engine is given and a report on the test result follows.

WHILE in the field of large diesel engines the four-stroke cycle is gradually being displaced by the two-stroke cycle; in road vehicles the transition takes place rather slowly. The reason for this may be found in the problem of scavenging at the rotational speeds required by road vehicles. It is difficult so to direct the scavenging air stream that it cleans out the entire cylinder without dissolving into a chaotic turbulence.

The uniflow scavenging system avoids this difficulty as it guides the air stream from end to end through the cylinder and effects a thorough cleaning of it. Constructive simplicity is sacrificed however, because uniflow scavenging requires either opposed pistons, poppet valves, or sleeve valves; all undesirable complications. In road vehicles the two-stroke cycle engine will become really popular when it becomes simple and cheap. This objective, it is claimed, has been accomplished by the designer of the Krauss-Maffei engine, the inventor Adolf Schnürle who died May 24, 1951.

To realize a loop or reverse scavenging, Schnürle placed the inlet ports on both sides of the exhaust ports, so that the incoming air enters in two streams uniting on the cylinder wall opposite the exhaust ports, flows upward, turns under the cylinder head and then flows downward on the other side to the exhaust ports.

In a conventional cross-scavenged engine the inlet ports are placed on one side of the cylinder and the exhaust ports on the opposite side of the cylinder. This frequently results in considerable "short-circuiting", or flow of air directly from inlet to exhaust ports. Consequently the top part of the cylinder is inadequately scavenged. In the Schnürle system of scavenging, as shown schematically in Fig. 3, the air stream first hits the opposite cylinder wall and is forced thereby to travel up to the cylinder head before it is deflected downwards. The air flow is thus "disciplined" through its entire journey, guided by solid surfaces. This guidance permits an orderly flow at almost any piston speed. All ports are controlled by the top edge of the piston without any other means of control such as poppet valve, slide valve, or automatic valve.

Fig. 1 shows right- and left-hand views of the engine and Fig. 2, its longitudinal and transverse sections. Having four cylinders 120 mm × 130 mm (4·724 in × 5·118 in), it develops 145 continuous net horsepower at 2,200 r.p.m. or, intermittently, 160 horsepower at 2,300 r.p.m. The overall dimensions are 35 in long, 36 in wide, and 44 in high, and weight with all standard accessories is 1,579 lb or 10·9 lb/hp. That such small external dimensions and light weight are possible with a cast iron structure in an engine built for thousands of hours of service under severe road conditions is evidence of the outstanding character of the Schnürle design.

Description of the engine

The four cylinders are arranged at 90 deg, which gives equally spaced firing. The combination of two-stroke-cycle and 90 deg V-type is hard to beat in simplicity and compactness. In evenness of firing it equals an eight-cylinder four-stroke engine, but

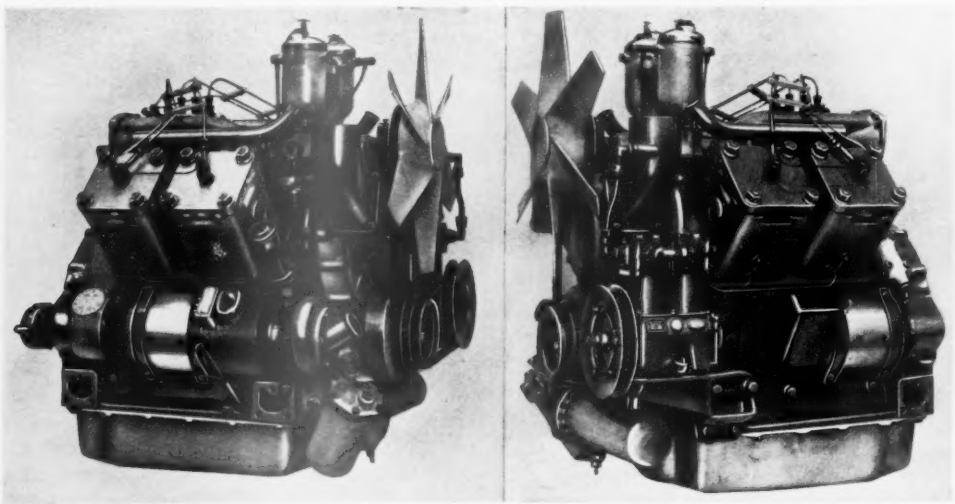


Fig. 1. Krauss-Maffei engine type KMD6. Continuous output 145 b.h.p. at 2,200 r.p.m.

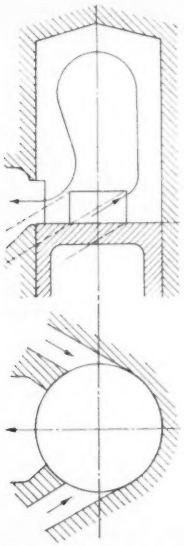


Fig. 3. Diagram of the Schnürle loop-scavenge system

it is much shorter than a V-eight or even an in-line four. An objection frequently voiced against the two-stroke cycle engine is that it requires greater centre distance between the cylinders, which entails greater engine length, and thus the advantage of increasing the power output by doubling the number of firing strokes is largely nullified. In the two-stroke cycle V-engine, however, the greater centre distance does not increase the total length, because the cylinders are arranged in two banks and spaced as close as the bearings allow. This is the principal reason of shortness of the Krauss-Maffei engine.

The running mechanism consists merely of the double-throw crankshaft, Fig. 4, four connecting rods and four pistons, together with a few gears for driving the fuel injection pump, the scavenge blower, and other accessories. These are almost the only moving parts. The cylinders have no valves whatever beyond the injection valve centrally located in the cylinder head. This simplicity of construction is responsible for fulfilling a most important requirement of a vehicle engine: dependability in service.

The four-cylinder V-type arrangement not only allows a very compact construction, but it also results in good balance. The rotative part of the masses is completely balanced by a counterweight on the belt pulley at the blower end and a cavity in the flywheel on the opposite end. Of the reciprocating inertia forces, the forces of the first order and the couples of the first and second order are balanced. Second order forces cannot be balanced, and they tend to oscillate the engine in the horizontal plane at right angles to the longitudinal axis. However, since the natural frequency of the frame is much lower than the frequency of these inertia forces (twice engine r.p.m.), this unbalance does not result in vehicle vibration, as the authors had occasion to observe in extended road tests.

The crankcase is a one-piece casting of iron, and to the base an aluminium oil pan is attached. In the illustration, Fig. 5, (A) indicates the passages from blower to receiver, (B) the air receiver, and (C) the delivery ducts to the cylinders. The two upper surfaces inclined at 45 degrees accommodate the cylinders, each of which is held with four substantial studs which also secure the cylinder head and transmit the combustion pressures directly to the well-ribbed crankcase. The upper portion of the crankcase

Fig. 6. Blower impeller

serves as the airbox or scavenging receiver, closed with a cast cover which carries the injection pump. To the front the aluminium blower casing is attached, the diffuser of which connects with the airbox. The cast aluminium blower impeller is shown in Fig. 6.

The crankshaft is short, generously proportioned and, as the throws are in one plane, easy to manufacture. No counterweights are used, but one of the crank webs carries a gear for the accessory drives. All three main bearings are 4 in diameter and 2 in long. The side-by-side connecting rod bearings are $3\frac{1}{4}$ in diameter and $1\frac{7}{8}$ in long. All this results in a very short engine, in spite of the generous centre distance (1·85 × bore) between cylinders.

The cylinders are individual castings provided with integral cooling jackets. The lower part of the cooling jacket is formed by the crankcase. Both air and water enter the cylinders through their bottom seats. This ingenious cylinder design greatly facilitates assembly and dismantling and permits inexpensive replacement of worn

Fig. 4. Crankshaft, connecting rods and pistons

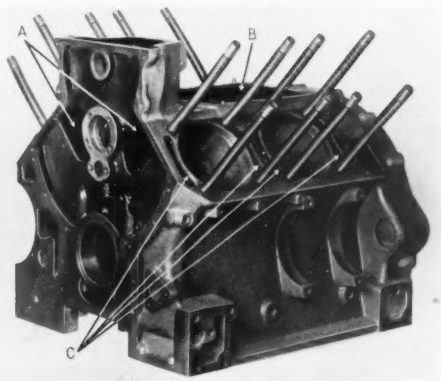


Fig. 5. Crankcase incorporating air receiver

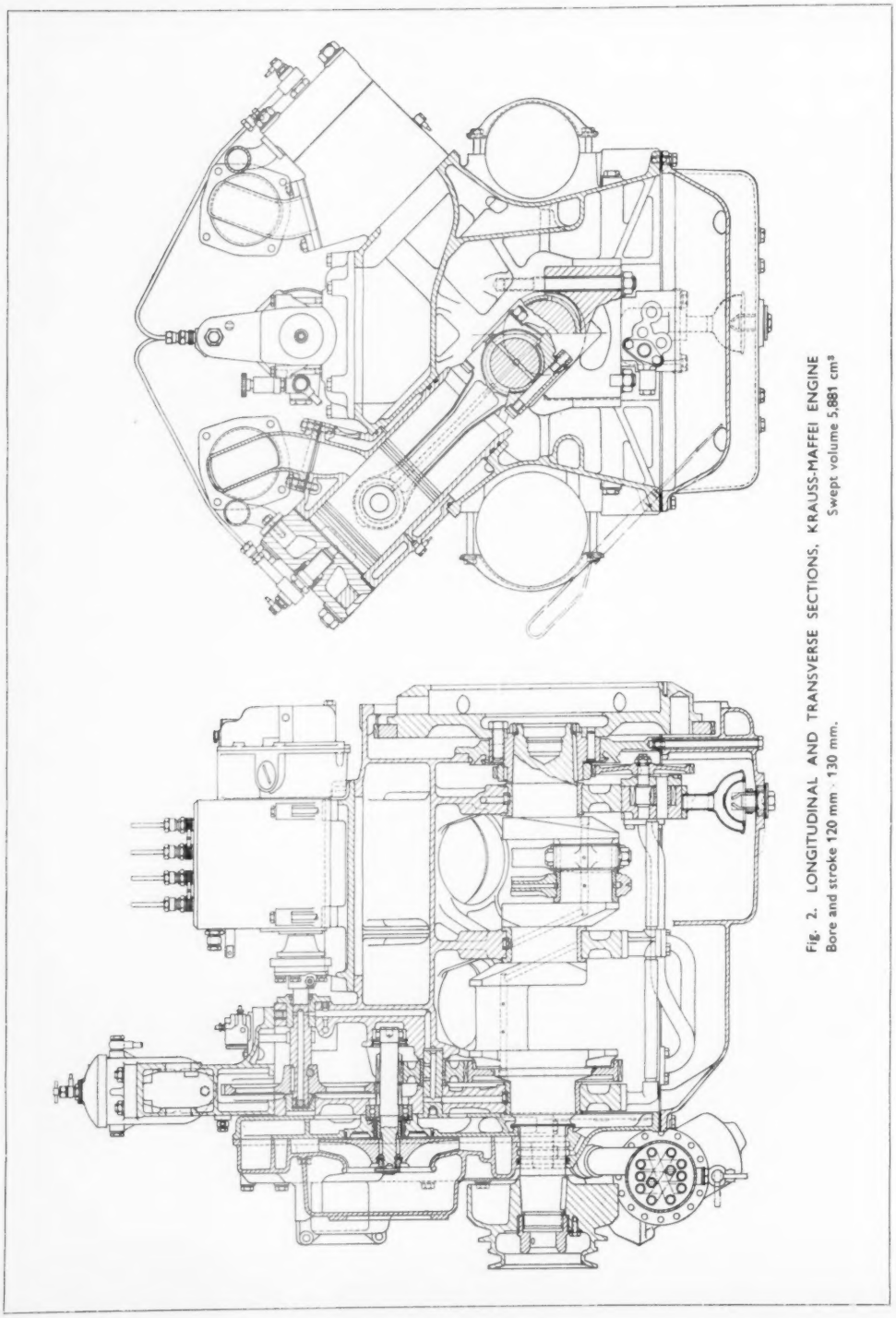


Fig. 2. LONGITUDINAL AND TRANSVERSE SECTIONS, KRAUSS-MAFFEI ENGINE
Bore and stroke 120 mm × 130 mm. Swept volume 5,881 cm³

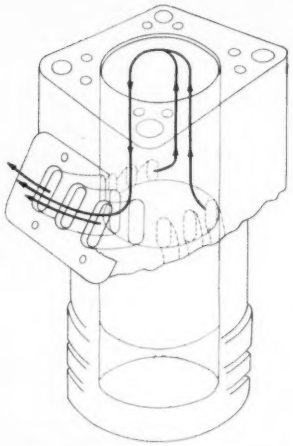


Fig. 7. Schematic arrangement of cylinder ports

components. Fig. 7 shows schematically the arrangement of inlet and exhaust ports in the cylinder.

A marked advantage of the loop-scavenged engine is the extraordinarily simple cylinder head required. It is made of silicon-aluminium and contains a cavity for the coolant and a central hole for the injector and nothing more. The combustion space is formed by a shallow cavity in the cast iron piston. The injection pump is driven by the uppermost wheel of the gear train shown in Fig. 8, the pinion of which drives the scavenging blower. The Bosch fuel injectors have six-orifice nozzles of Deckel manufacture and open at approximately 3,000 lb in^2.

Mounted in the crankcase at the rear, the lubrication gear pump draws oil from the sump of the crankcase and delivers it through a pipe to the oil filter and oil cooler at the front end of the engine, whence it is conducted through another pipe to the centre crankshaft bearing. Here the oil lines branch off to each end bearing. Drilled holes in the crankshaft carry the oil to the four connecting rod bearings and thence it passes through the drilled connecting rods to the gudgeon pin bearings. The gear and auxiliary shafts get their lubrication also through drilled holes. Pistons are lubricated by splash, but the cylinder walls receive additional lubrication from a fine metering, precision plunger pump through a small drilled hole in the cylinder wall. This pump is driven through helical gears from the injection pump shaft and so regulated by the control rank of the injection pump that the metered quantity increases with the load. For this oil a second oil filter is provided, visible in Fig. 1 on top of the engine.

On the right the electrical generator and the water pump are driven from the same shaft from a gear mounted on the hub of the flywheel through an intermediate gear. A brake compressor and a cooling fan are driven by individual vee belts from the front end of the crankshaft.

Engine tests

An engine was subjected to a thorough investigation on the manufacturer's test stand; another, mounted on a heavily loaded bus chassis, went through extended road tests. All laboratory and road tests were continuously supervised by the authors and their associates, two experienced engine experts. The test results presented here are as they were recorded by the authors and their associates.

Complete measurements were made with calibrated instruments. The power output was measured by a water dynamometer, the fuel consumption by clocking the time for 250 cm^3 fuel to flow through a burette. Air consumption was measured by a standard thin plate orifice and an inclined manometer. The quantity of cooling water passing the engine was determined by temporarily diverting it into a tank and clocking the time needed to draw 10 kg water. Commercial German diesel fuel was used, of 0·839 specific gravity, 221 deg F flash, 54·7 cetane number, and lower heating value of 18,450 B.Th.U lb. Graph sheets, Figs. 9 to 19, represent the most important test results.

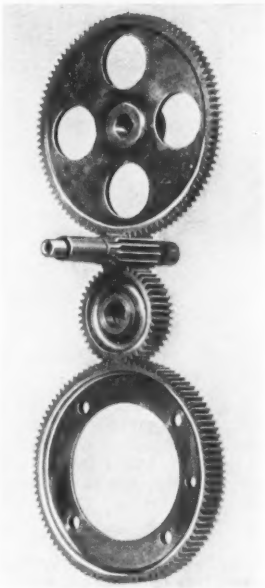


Fig. 8. Gears for blower and injection pump drive

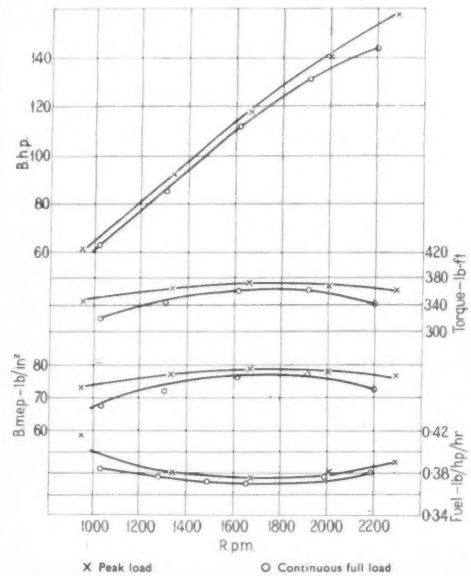


Fig. 9. Power output, torque, b.m.e.p. and specific fuel consumption against r.p.m.

Fig. 9 shows power output torque, b.m.e.p. and specific fuel consumption plotted against r.p.m. At loads corresponding to test points marked with circles the exhaust of the engine was clear to visual observation. The curves marked with crosses indicate such overload at which exhaust discoloration begins, but the engine could run at this load for a long period without sooting up.

In Fig. 10 the characteristic curves of the engine are given. The region of optimum fuel consumption is between 1,200 and 1,600 r.p.m. and between 57 and 67 b.m.e.p. At 1,265 r.p.m. and 59·1 b.m.e.p. the authors have reliably measured 0·343 lb b.h.p/hr and at 1,250 r.p.m. and 64·8 b.m.e.p., 0·347

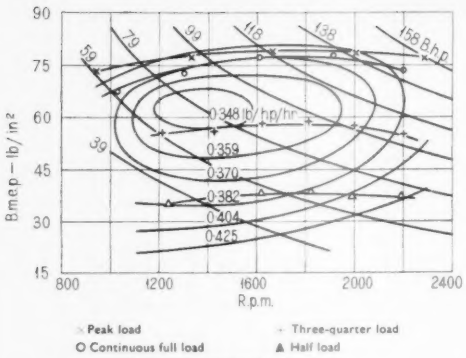


Fig. 10. Characteristic curves

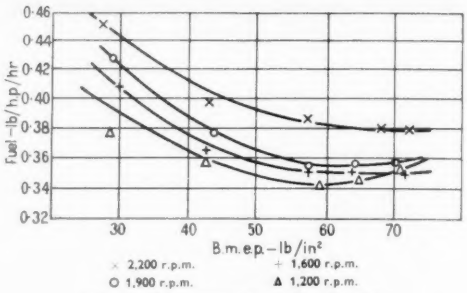


Fig. 11. Fuel consumption against b.m.e.p.

lb b.h.p hr. These figures are uncorrected for barometer and temperature. The metric figures were 153 and 155 grams $PS_e h$ and in the above conversion they were reduced corresponding to the 1·4 per cent smaller metric horsepower. These are values which can hardly be improved on with engines of this size, two-stroke or four-stroke cycle.

In the wide speed range between 1,200 and 1,900 r.p.m. and with loads between 40 and 70 b.m.e.p. the fuel consumption never exceeded 0·36 lb b.h.p hr.

The characteristic may also be viewed as a three-dimensional diagram of which the third ordinate is the specific consumption. If we intersect this three dimensional diagram at 1,200, 1,600, 1,900 and 2,200 r.p.m. we obtain the consumption curves of Fig. 11 as a function of b.m.e.p. shown at these four speeds. In most of the operating range the specific fuel consumption does not exceed 0·36 lb b.h.p hr. It will be appreciated that this means more than the saving of a certain amount of fuel costs per year, because it must be a refined engine indeed that operates with such a remarkably low fuel consumption.

TABLE I

R.p.m.	Output h.p.	Compression lb in⁻² (gauge)	Firing pressure lb in⁻² (gauge)
1255	78	595	1224
1735	113·2	684	1324
2180	142	710	1368

Two cylinder heads were provided with indicator holes into which the quartz pick-ups of a piezo-electric indicator were mounted. For calibration, the indicator was connected to a pressure chamber. When this chamber was gradually filled with air from a bottle, the diagram peak on the oscilloscope sank, and with sufficiently high back pressure it disappeared completely and remained only the glowing base line. The pressure read on the control pressure gauge in this instant was equal to the firing pressure. With this method at 71 b.m.e.p. load pressures were measured as in Table I. For the very strongly built crankshaft these pressures are by no means too high.

Another point of interest was the determination of the air quantities and the delivery ratio, that is, the volume of free air sucked by the blower per stroke divided by the displacement volume. According to Fig. 12 the air consumption increases linearly with the engine speed, and the delivery ratio is almost independent of the load and practically constant and equals 1·3. The airbox pressures are given in Table II.

TABLE II

R.p.m.	Pressure lb in⁻² (gauge)
960	0·71
1,520	1·7
2,060	3·15
2,200	3·7

These pressures are unusually low; only about half those expected in small, high-speed, two-stroke cycle engines. These low airbox pressures are responsible for the small parasitic horsepower absorbed by the blower. Every pound increase in airbox pressure reduces the net b.m.e.p. of the engine by approximately 2 lb, therefore, if good scavenging is accomplished by low airbox pressures the power output and fuel economy must improve.

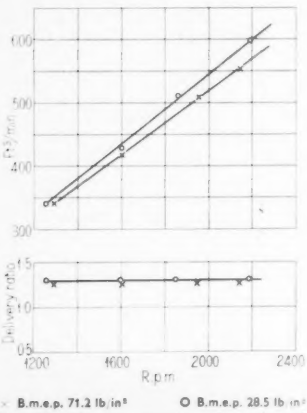


Fig. 12. Air consumption (upper) and delivery ratio (lower) against r.p.m.

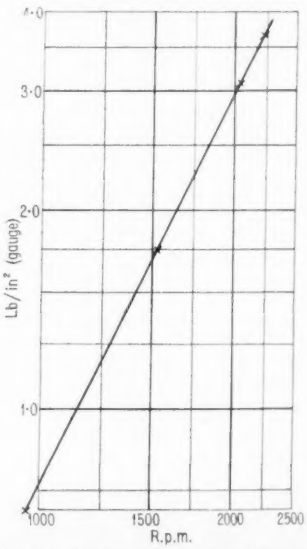


Fig. 13. Airbox pressure against r.p.m.

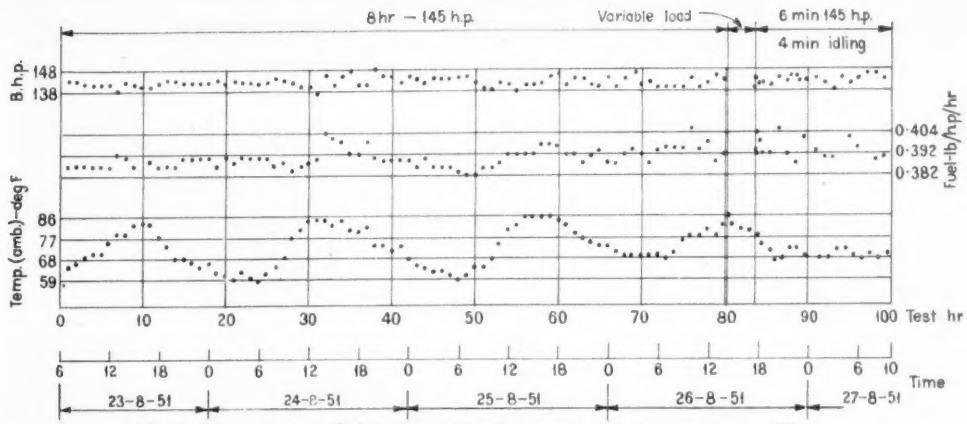


Fig. 14. Power output, specific fuel consumption and room temperature during a continuous 100-hr run

Still more can be learned from the airbox pressures. As far as the air flow is concerned the engine acts the same was as if it were a fixed orifice; the rate of flow increases in proportion with the square root of the pressure drop. If we plot on a logarithmic scale the airbox pressures against the r.p.m., as is done in Fig. 13, we obtain a substantially straight line with an inclination of 2:1. The pressure, therefore, increased as the square of the r.p.m. The rate of air flow on the other hand increases as the square root of the pressure drop. From these it follows that the air flow per minute was proportional to the r.p.m. or the air flow per cycle was independent of the r.p.m.

The reason for putting so much emphasis on this point is that there is widespread belief among engineers that a geared centrifugal blower is unsuitable for charging a two-stroke cycle engine because it would not deliver enough air at low speed. This is a fallacy. The characteristics of a well-designed centrifugal blower match the requirements of the two-stroke cycle engine perfectly, producing an equally good filling at low speed as at high speed.

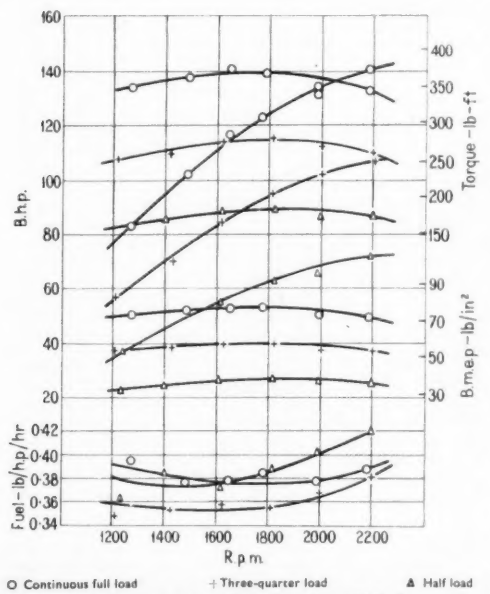


Fig. 15. Power output, torque, b.m.e.p. and specific fuel consumption taken during the 100-hr run after 80 hr

A precise measurement of the cooling water flow through the engine was omitted because the cooling condition in the vehicle-mounted engine differs considerably from the test stand engine and the results would not be transferable from the former to the latter. The water pump delivery at various engine speeds is given in Table III.

The flow quantity rises proportionally to the rotative speed up to 1,600 r.p.m. and flattens out after that. At 64 b.m.e.p. the heat rejected to the cooling water was as listed in Table IV. To generate one horsepower hour we burn in this engine roughly 0·35 lb fuel yielding 6,460 B.Th.U. against the 2,544 B.Th.U. which is the physical equivalent of one horsepower hour. Accordingly, of the total fuel energy $100 \times 2544/6460 = 39{\cdot}4$ per cent is converted into useful power and $100 \times 1550/6460 = 23$ per cent

TABLE III

R.p.m.	Delivery lb/min.
1,000	194
1,200	235
1,400	275
1,600	312
1,800	330
2,000	339
2,200	341

is rejected to the cooling water, leaving approximately 37 per cent to go out with the exhaust. The cooling was more than adequate at all loads.

100-hour run

After completing the individual tests that extended over several days, the engine, without cleaning or overhauling, was subjected to a 100-hour continuous test at 145 b.h.p. and 2,200 r.p.m., which were kept as constant as possible. During the entire period, the engine was subject to uninterrupted and unbiased supervision. Of the hourly readings in Fig. 14 only power, fuel consumption, and room temperature are recorded. The influence of room temperature upon fuel consumption is noticeable. The average fuel consumption was 0·390 lb/b.h.p/hr. In spite of a light sooting up of the exhaust ports, after completion of the 100-hour run no decrease in output or increase in fuel consumption was observed.

This was also checked by intermediate tests inserted after 80 hours without stopping the engine. The results shown in Fig. 15 practically duplicated the fuel consumption figures measured before the 100-hour run.

In the last 16 hours of the continuous run, 6 minutes at full load was alternated with 4 minutes idling at 500 r.p.m. The engine always took the full load willingly. During the first 80 hours the lubricating oil consumption was 0·8 litre hr which corresponds to 0·011 lb b.h.p hr.

Inspection of the engine

After the 100-hour run the engine was stopped and dismantled. All

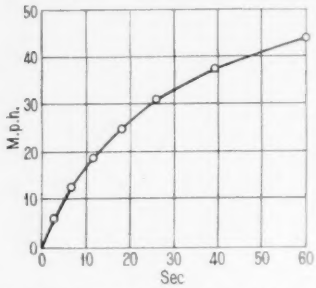


Fig. 17. Acceleration times of vehicle by switching gears

components, bearings, cylinders, and pistons showed unblemished running surfaces. Only on one piston was the top piston ring slightly sticky, all the rest were so loose that they fell by their own weight. The injectors were in good condition, with no craters or heavy deposits. The six orifices were open and gave a symmetrical spray and good chatter in the nozzle test stand.

An outstanding feature of the Krauss-Maffei engine is the ease of its dismantling. Individual cylinders can be lifted in about an hour and the pistons can be pulled without removing

TABLE IV

H.p.	B.Th.U hr.	B.Th.U h.p hr.
72	115,000	1,600
100	154,000	1,540
127	197,000	1,550

TABLE V

Velocity, miles hr.	Miles gallon	Ton-miles gallon
12·81	23·46	306
21·18	23·85	311
32·01	19·30	251
41·80	15·73	205
53·01	12·92	168

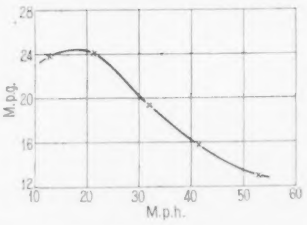


Fig. 16. Fuel consumption of bus weighing 29,210 lb against vehicle speed

the oil pan. All auxiliaries are easily accessible. This makes servicing easy and convenient. The ease of service and the unusually small number of wearing parts (and all parts) which must be stocked should make this engine popular with the dealers and fleet owners.

Road tests

The laboratory tests were followed by road tests on super-highways (autobahns) and secondary roads. The vehicle had a certified total weight of 29,210 lb.

The travelled stretch totalled 1,060 miles and was covered without encountering any trouble. Grades of 18 per cent and at one spot even 22 per cent were negotiated. The exhaust was barely visible and completely satisfactory.

The primary object of the road test was to prove the reliability of the engine, which it has done to complete satisfaction. Other objects were to measure the fuel and lubricating oil consumptions under road conditions and to determine the rate of acceleration.

Economy runs were travelled in both directions and the averages computed. Velocities were determined by clocking the time of the kilometer stones which are placed on the autobahn every 500 metres. The fuel consumption was determined by the decrease of the fuel level in a measuring burette. The performance is recorded in Table V.

In Fig. 16 the measured values are marked by crosses. If the axles and tyres had permitted heavier loading, higher ton-miles per gallon figures could certainly have been achieved. Over a distance of 716 miles the lubricating oil consumption was 632 miles per gallon.

Of the extensive test programme, the acceleration test may finally be mentioned. For these tests a level stretch was selected and run in both directions. Starting from test and switching gears, the vehicle accelerated in 60 seconds from zero to 43·5 m.p.h. Using only the sixth (high) gear it took 54·4 seconds to accelerate from 18·6 m.p.h. to 43·5 m.p.h. (Figs. 17 and 18).

The Krauss-Maffei KMD6 engine was investigated by the authors in a thorough manner for almost three weeks on the test stand and on the road. They can certify that it combines the simplest construction with

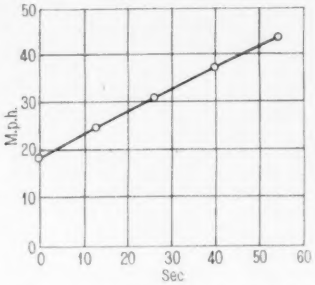


Fig. 18. Acceleration times of vehicle in sixth gear

high economy and great reliability.

The authors desire to express their thanks to the manufacturers for the use of the engines and vehicles, the provision of the necessary facilities and for permission to publish the results of the tests.

De-Rusting Process

AN alkaline de-rusting process for steel, cast iron, malleable iron, and iron alloys has been developed by Enthone Inc., New Haven, Connecticut. The new process is said to be unique in that no acid is required, thereby eliminating subsequent rusting, acid effect on the base metal, and possible corrosion of surrounding equipment. It is also claimed to be considerably faster than acid de-rusting methods.

Operation is described in *Products Finishing*, January 1952. Parts are immersed in the solution and electrically charged as cathodes for a period, varying from a few seconds to several minutes, depending on current density and the condition of the metal. A wide range of current density can be employed, ranging from five to several hundred amp/ft^2. The bath is controlled by titration. Treated parts are bright and clean and longer treatment does not result in any attack on the base metal, thus obviating the need for close supervision of the process. (2014)

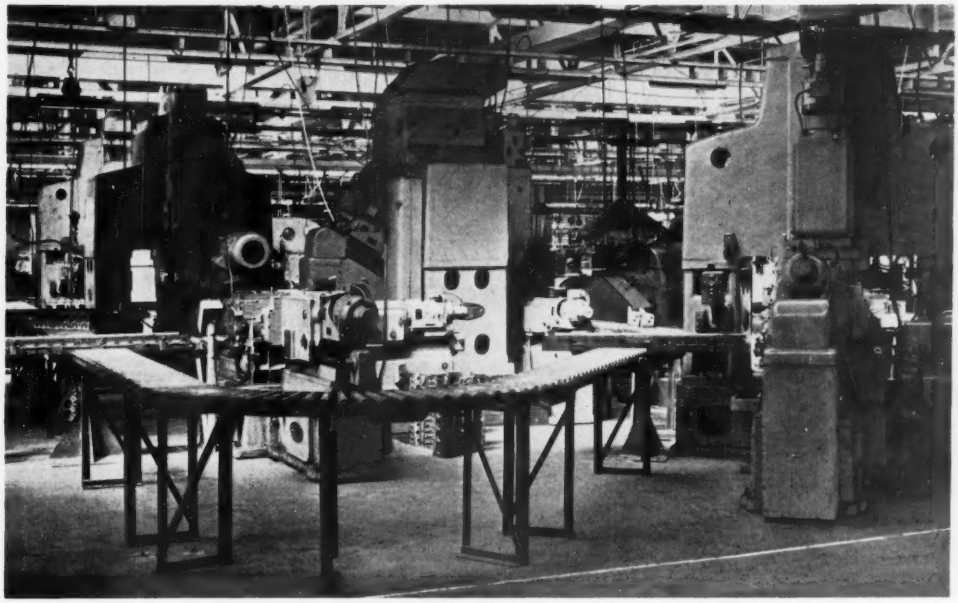


Fig. 26. A section of the machine line for Velox and Wyvern cylinder heads

ENGINE MANUFACTURE

Recent Production Developments at the Works of Vauxhall Motors Ltd.

(*Continued from page 222*)

Cylinder head machining

IN contradistinction to the cylinder blocks for Wyvern and Velox cars, it has been found possible to design the cylinder heads for the new square engines in such a manner that the heads for both four- and six-cylinder engines can be machined on one line without any re-setting of tools or fixtures at any machine. This, of course, has only been made possible by the very closest co-operation between the design and production engineers while the design was being developed.

Chromidium castings are used for the cylinder heads, and as on the cylinder blocks, a high standard of casting accuracy is specified and maintained. This eliminates any necessity for preliminary machining solely to provide location for subsequent operations. This conforms to the general policy that has been adopted in planning the machining for all the components of the new engines; namely, that handling shall be reduced to a minimum. Also for this reason, great use is made of multi-head machines in the cylinder head line. Part of this line is shown in Fig. 26.

The first three operations are carried out on milling machines specially developed by Cincinnati Milling Machines Ltd. for this application. These machines all have certain features in common, which may well be enumerated here instead of being described individually as each operation is discussed. For example, each machine incorporates a hydraulic feed unit with a range from 0 to 50 in per minute. Incidentally, the maximum feed rate is used on all three machines. Additionally, hydraulic clamping actuated by the push button that initiates the table cycle is used on each machine. A hydraulically-operated automatic ejector is also incorporated in each machine. Finally, all five machines have completely automatic table cycles. Each cycle is initiated by push button control and after the component is loaded into the fixture, the cycle is:—

(1) Table rapid traverse starts and clamps are applied.

(2) Table slows to feed rate for the cut.

(3) Table continues the forward stroke at rapid traverse rate. During this portion of the table stroke the clamps are automatically released and the automatic ejector advances to contact the component.

(4) The ejector automatically retracts to pull the component on to a roller track for transfer to the next machine, while the table returns at rapid traverse to the loading position.

For the first operation on the cylinder head, a special low-bed Cincinnati Hydromatic machine is used, see Figs. 27 and 28. It carries two cutters mounted on one vertical and one inclined horizontal spindle for finish milling the top face and the manifold face. Location for this operation is taken from a series of small pads cast on the joint face in accurate relationship with the crowns of the combustion chambers, and transverse location is taken from the sides of two combustion chambers. In loading, the casting is pushed against a retractable longitudinal stop. The table cycle is then initiated and three hydraulically-operated clamps are applied automatically. To give correct transverse location, the clamps for the tappet cover side are applied first and in such a manner as to push the casting across until the walls of the two appropriate combustion chambers contact stops in the fixtures. Only when this has occurred do the clamps on both sides effectively secure the casting.

Fig. 27. Cincinnati Hydromatic machine for milling the top and manifold faces

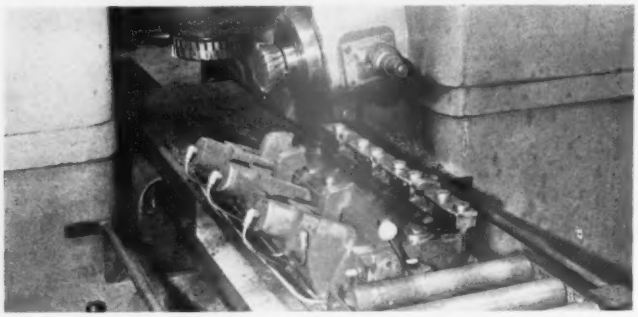


Fig. 28. The hydraulic clamping fixture for the machine shown in Fig. 27

Fig. 29. Cincinnati machine for rough milling the cylinder joint face

For this, and indeed for all the other operations on the cylinder head that are carried out on Cincinnati machines, the cutters have been developed by Cincinnati Milling Machines Ltd. in co-operation with Vauxhall Motors Ltd. and Richard Lloyd Ltd. They all incorporate a 20 deg corner angle with 10 deg positive axial rake and 20 deg negative radial rake. Specially thin cutter bodies have been developed to permit the use of a sufficient number of blades to give a maximum feed per tooth of 0·013 in, despite the very high feed rate.

On the machine for the first operation the vertical spindle carries a face mill 8½ in diameter and with 28 teeth for milling the top face, while the horizontal angular spindle carries an end mill 6 in diameter with 18 teeth for milling the manifold face. The cutting speed is 300 ft per minute, the feed 50 in per minute and the depth of cut $\frac{3}{16}$ in. During the forward stroke of the table a ratchet on the end of the ejector bar rides over the top face and finally drops to contact the following end of the casting. Before the end of the table stroke, the clamps are released, and as the table reverses the hydraulic ejector pulls the casting clear of the machine on to the roller track for transfer to the next machine in the line.

Between the first and second machines, the casting is turned over on to the machined top face. It is then loaded into a special low-bed vertical Cincinnati Hydromatic milling machine in which the joint face is rough milled to leave 0·030 in of stock to be removed later. As with the cylinder block milling machines, it would be possible to produce a sufficiently good quality of surface finish and dimensional accuracy to finish the joint face at this operation, but Vauxhall Motors Ltd. prefer to have a late finishing operation to ensure that the joint face is free from any damage or distortion.

The machine for the second operation, see Fig. 29, has a single vertical spindle in a bridge type spindle carrier mounted between two box-type headstocks. A 7 in diameter, 28 teeth face mill is used. It runs at 136 r.p.m. to give a cutting speed of 250 ft per minute. The depth of cut is $\frac{3}{32}$ in and the feed rate 50 in per minute. At the third operation the tappet cover face is machined on a Cincinnati special heavy-duty, plain Hydromatic milling machine that incorporates a low bed table unit. For this operation a 6 in diameter, 16 teeth end mill is used. It runs at 242 r.p.m. to give a cutting speed of 300 ft. per minute. The feed rate is 50 in per minute and the depth of cut $\frac{3}{16}$ in. As with the other Cincinnati machines, hydraulic clamping is employed and the work is automatically ejected on to the roller track when the machining is completed. This machine is illustrated in Figs. 30 and 31.

Machines that have been specially

developed for this line by William Asquith Ltd., Halifax, are used for the next ten operations. With one exception, a travelling head milling machine, the Asquith machines are all tooled for drilling, reaming, tapping, spotfacing or counterboring operations. As one of the chief terms of reference in planning this line was that the machining should be completed with the least possible amount of handling, the drilling, reaming and tapping machines are all multi-spindle, and at eight stations two or more multi-spindle heads operate simultaneously.

Before the operations carried out on the Asquith machines are described, some remarks that apply to all the machines may not be out of place. Although the machines have been specially built for machining the cylinder heads for Velox and Wyvern engines, they are in very great measure fabricated from standard drive units. Each drive and feed unit, whether screw-feed or cam-feed, is taken from the range of Asquith standard units. The units are so designed that they can be applied to milling, drilling, reaming, tapping or boring machines. They can also be arranged to operate vertically, horizontally, or indeed, in any desired disposition. An appropriate multi-spindle head is attached to the drive and feed unit.

This method of construction has been adopted by William Asquith Ltd. because it simplifies modification to suit design changes. When changes are made, only the actual multi-spindle head need be changed. This means that although the machines are in effect special purpose machines, modifications can be effected at a relatively low cost. The machines all operate on electrical-mechanical principles. This is standard Asquith practice. It gives very accurate control of the machine functions, and in addition maintenance is very simple. On every machine, the various functions are so inter-connected that until the work is correctly located the machine drive cannot be started. Pneumatic clamping is employed on all the Asquith machines.

The first of the Asquith machines is a vertical 19-spindle drill with a tunnel-type fixture into which the casting is loaded with the top face down and the rear end leading. Height and transverse locations are taken from previously milled faces, and longitudinal location is from a female vee in the fixture which contacts the edges of two combustion chambers. On the six-cylinder head this machine combination drills and reams 12 tappet holes and drills seven other holes in the joint face.

Before the next operation, the casting is turned over to bring the top face uppermost. It is then loaded into a tunnel type fixture with the rear end leading to have the front end milled. A travelling head horizontal milling machine with a screw-feed unit is employed. Through loading is employed and the casting has to pass the milling head before entering the

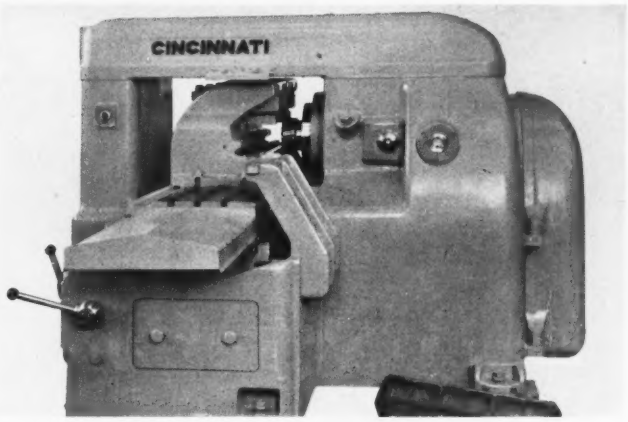


Fig. 30. The loading end of the machine for milling the tappet cover face

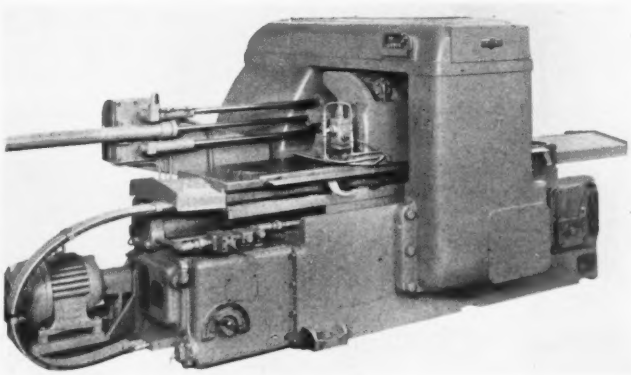


Fig. 31. The automatic ejector mechanism on the machine shown in Fig. 30

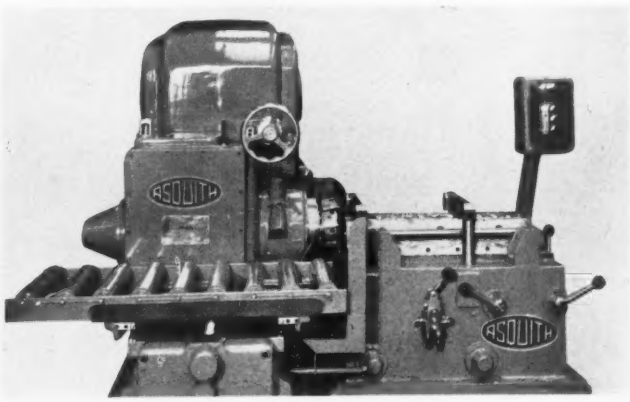


Fig. 32. Asquith travelling head machine for milling the front end

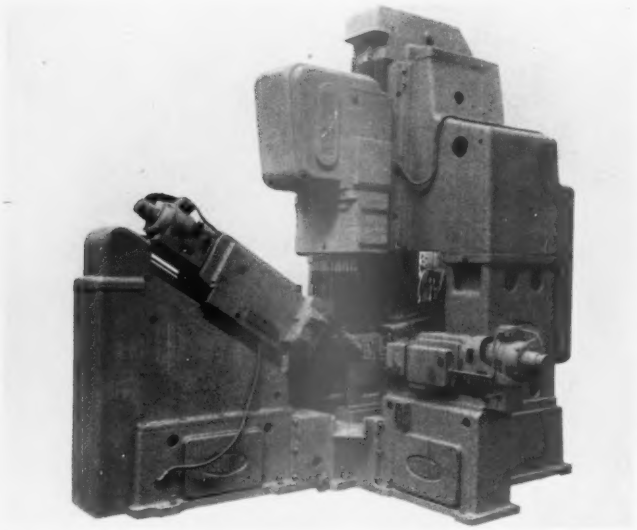


Fig. 33. Asquith four-way machine with one vertical, two angular and one horizontal multi-spindle heads

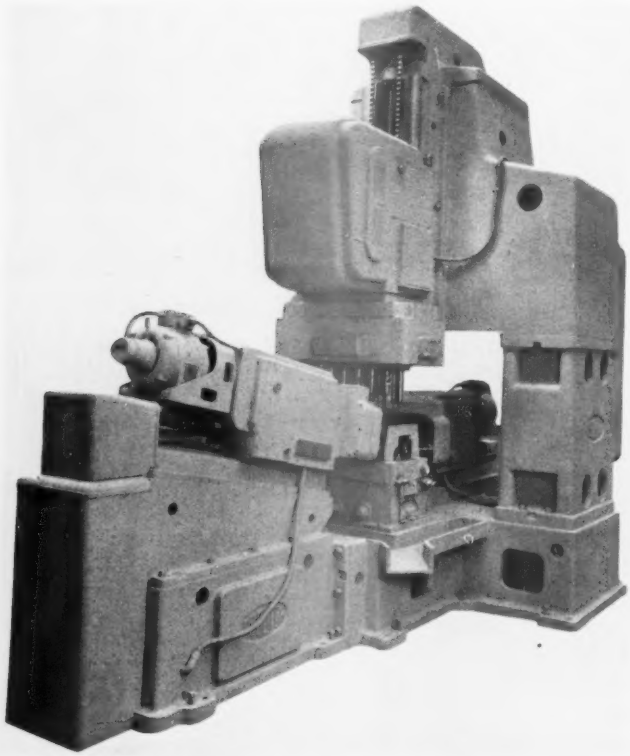


Fig. 34. Three-way Asquith machine for drilling holes in joint, manifold and tappet cover faces

fixture. To allow easy passage to the fixture a short length of independent roller track is attached to the milling head. An 8 in diameter Galtona face milling cutter with 12 tungsten carbide tipped serrated blades is used. With the exception of the final milling operation on the joint face, this completes the milling. This machine is illustrated in Fig. 32.

An Asquith four-way drilling machine, illustrated in Fig. 33, is used for the next operation. The work is loaded into the fixture with the front end leading and the joint face down. From a vertical head with a screw feed unit, 12 tappet holes are combination drilled and reamed, six valve guide holes are drilled to leave an allowance for reaming and fine boring at subsequent operations, and 10 other holes are drilled in the top face. At the same time a right-hand angular head with a 4 h.p. cam-feed unit drills six spark plug holes in the tappet cover face, a left-hand angular head with a 2 h.p. cam-feed unit counterbores three holes in the manifold cover face, and a rear horizontal head with a 2 h.p. cam-feed unit drills four holes in the front end of the casting.

This machine and the next in the sequence are placed one on either side of the roller track. To allow the casting to be directed to these machines there is a turntable in the roller track. The head is loaded into the first machine with the front end leading and when the operation is completed it is pushed straight across to be loaded into the fixture of the next machine with the rear end leading.

A three-way multi-spindle drilling machine is used at the next operation. It has a vertical head with a screw-feed unit for drilling six valve guide holes and 11 other holes in the top face; a right-hand angular head with a 4 h.p. cam-feed unit for drilling 10 holes in the manifold face: and a left-hand horizontal head for drilling seven holes in the tappet cover face. This machine is shown in Fig. 34.

For the next operation an Asquith duplex drilling machine, Fig. 35, is used. Before the casting is loaded into the fixture on this machine it is turned on to the tappet cover face. Then a right-hand horizontal head with a screw-feed unit drills seven holes and reams four holes in the joint face, while a left-hand horizontal head with a 4 h.p. cam-feed unit spotfaces six valve guide holes in the top face. The tooling on this machine is shown in Figs. 36 and 37.

The cylinder head is then unloaded on to a turntable in the roller track, on which it is turned through 180 deg so that the front end leads. It is also turned over to bring the top face uppermost. In this position it is loaded into an Asquith three-way multi-spindle drilling machine. On this machine a vertical head with a screw-feed unit spotfaces six valve guide holes and seven bolt holes in the top face. At the same time, a right-hand

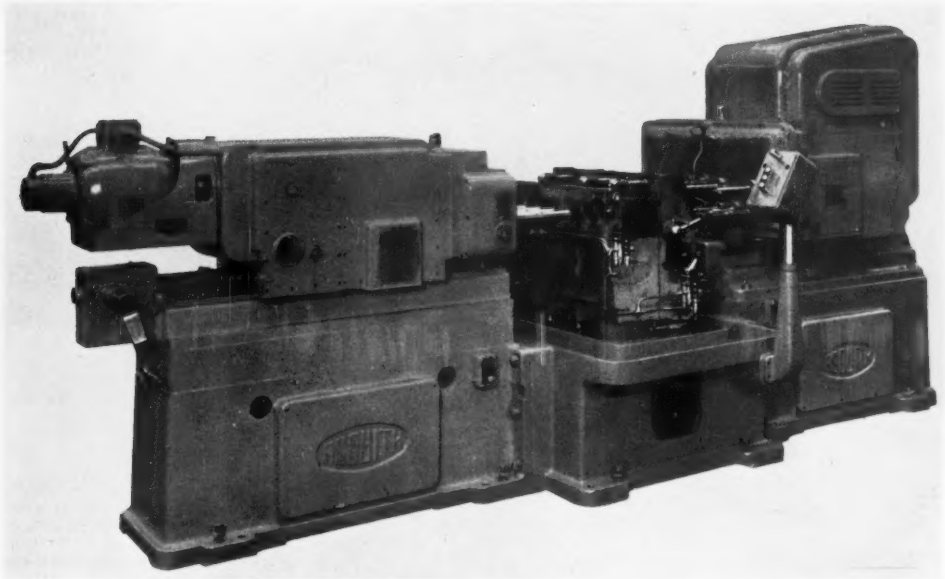


Fig. 35. Asquith duplex drilling machine for drilling and reaming holes in the joint face and for spotfacing holes in the top face

angular head with a 4 h.p. cam-feed unit counterbores six spark plug holes in the tappet cover face, and a left-hand horizontal head with a 4 h.p. cam-feed unit counterbores six holes in the manifold face. Between this station and the next, all the tapping holes in the cylinder head are countersunk. An air drill suspended on a balancer above the roller track is used.

At the next operation a three-way multi-spindle drilling machine, see Fig. 38, is used. All the heads are horizontal. The right-hand head has a 4 h.p. cam-feed unit, and reams six valve guide holes in the top face: the left-hand head also has a 4 h.p. cam-feed unit tooled for drilling 12 water circulation holes and for combined boring and facing three inlet and three exhaust valve throats in the joint face; the rear horizontal head has a 2 h.p. cam-feed unit for counterboring a radius in the front face of the casting.

This operation and the one immediately succeeding are carried out on machines placed one on either side of the roller track. The second machine of this pair is an Asquith duplex drilling machine with two 4 h.p. cam-feed units shown in Fig. 39. The right-hand head is tooled for combined boring and facing three inlet and three exhaust valve throats in the joint face, while the left-hand head reams six valve guide holes in the top face. In each case an allowance is left for fine boring at subsequent operations. Before any further machining, the block is turned on to the joint face and the tapping holes are blown out with compressed air.

An Asquith four-way machine with three tapping heads and one counterboring head is used for the next operation. A vertical head with a 4 h.p. cam-feed unit taps seven holes in the top face; a right-hand angular head with a 4 h.p. cam-feed unit taps 10 holes in the manifold face; a left-hand horizontal head with a 4 h.p. cam-feed unit taps seven holes in the tappet cover face; and a rear horizontal head with a 2 h.p. cam-feed unit counterbores two core plug holes in the rear end. This machine is shown in Fig. 40 and the tooling in Fig. 41.

Further tapping is then carried out on an Asquith three-way multi-spindle

Fig. 36. The tooling for spotfacing valve guide holes on the machine shown in Fig. 35

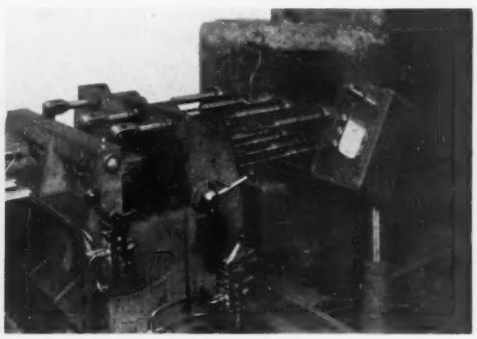


Fig. 37. The drilling and reaming head of the Asquith machine shown in Fig. 35

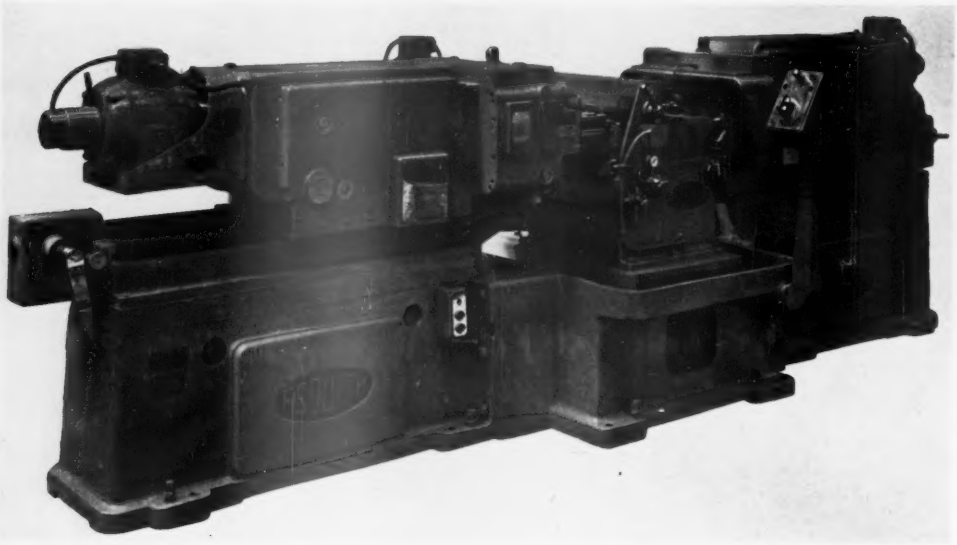


Fig. 38. Three-way horizontal drilling machine tooled for reaming holes in the top face, drilling, boring and facing holes in the joint face, and counterboring a radius in the front end face

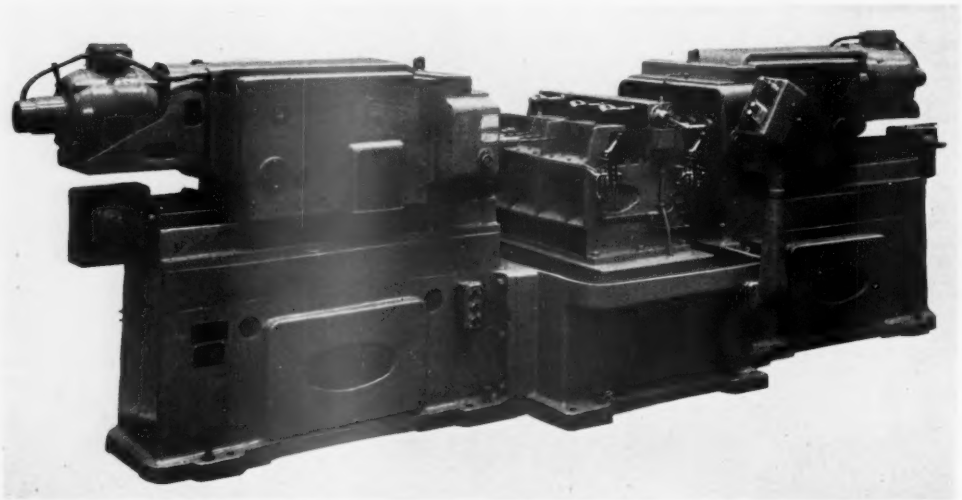


Fig. 39. Asquith duplex drilling machine with cam unit heads for boring and facing holes in the joint face and reaming holes in the top face

machine. At this operation seven rocker bracket holes and a rocker cover hole in the top face are tapped from a vertical head with a 4 h.p. cam-feed unit; a rear angular head also with a 4 h.p. cam-feed unit taps six spark plug holes in the tappet cover face; and a left-hand horizontal head with a 2 h.p. cam-feed unit taps four holes in the front end. Special Asquith tap holders are employed. Among other advantages they give complete protection against tap breakage should any faults have arisen during the drilling operations.

After the drilling, reaming and tapping operations are completed, the valve elements are machined. All these elements are finish machined before the valve guides are inserted. This sequence was first adopted by Vauxhall Motors Ltd. some two years ago for machining the valve elements of Bedford engine cylinder heads with such good results that it is now standard practice throughout the factory. On any component that passes through a multiplicity of machining operations, there is usually one operation which gives rise to more necessity for rectification, if not outright rejection, than any other. With cylinder heads, it was the experience of Vauxhall Motors Ltd., and we believe this is true of other organizations, that by far the greatest single cause of trouble was lack of concentricity between the valve guide bore and the valve guide seat.

Previously, it was the practice to finish machine the valve seats after the valve guides had been inserted in the cylinder head. This is still general practice in the automobile industry. The method of machining the valve seat from the valve guide bore does seem to be logical, but in practice it was found necessary to carry out an appreciable amount of rectification to maintain the required concentricity. With the new method rectifications to correct lack of concentricity are negligible in numbers.

For machining the valve elements in the cylinder head, special Precimax fine boring machines have been developed by John Lund and Co., Ltd., Crosshills, Keighley. There are two of these machines in the line, one for the exhaust valve and the other for the inlet valve elements. Apart from the necessary differences in tool setting, the machines are identical. One of these machines is illustrated in Fig. 44.

Each machine has three special heads, and two passes are required on the first machine for machining the elements of all the exhaust valves, and two on the second for machining the elements of all the inlet valves. Two passes are necessary because, although the machine heads are marvellously compact, the minimum possible centre distance between spindles is greater than the centre distance for adjacent valves. Each head carries three tool bits, one for boring the hole to take the valve guide, one for turning the valve seat and one for machining a counterbore. The boring and counterboring tools are fixed in relation to the spindle axis, but the turning tool for the valve seat operates from an angular slide in the head to produce the desired angle. This angular slide is operated by hydraulic mechanism at the rear.

In addition to its inherent accuracy, this machine also incorporates a complex automatic cycle. The work is loaded with Nos. 1, 3, and 5 valve guide holes in line with the machine spindles and the cycle is then initiated by push button. From the starting position there is quick approach of the table to the start-boring position. At this point the table movement is automatically slowed down to the feed rate and the spindles are started up at the high speed, 1,500 r.p.m. When the boring tool has completed its passage through the hole for the valve guide, the spindle speed is automatically reduced to 750 r.p.m. and the counterboring tool comes into action. At the end of the forward stroke the table runs against a positive stop and is then retracted 0·010 in. This retraction is included in the cycle to prevent the counterbore tool from rubbing against the recess while the tool on the angular slide is generating the valve seat. This is important both for quality of finish and for tool life.

At the end of the generating stroke, the angular slide is reversed and at the same time the table starts on the return stroke. When the reverse stroke of the table has brought the component clear of the counterboring tool, the spindle speed is automatically increased to 1,500 r.p.m. Meanwhile the table reverse stroke is at feed rate and the boring tool takes a finishing spring cut on the bore for the valve guide. As soon as the table has withdrawn sufficiently to bring the component clear of the boring tool, the table reverse is accelerated until the outermost position is reached. At this point the top slide of the hydraulically-operated cross slide is automatically and accurately indexed to the second position to bring Nos. 2, 4 and 6 valve guide holes into line with the machine spindles. The cycle is repeated and the table finally returns to the starting position for unloading and re-loading. A similar machine cycle is used for the inlet valve elements.

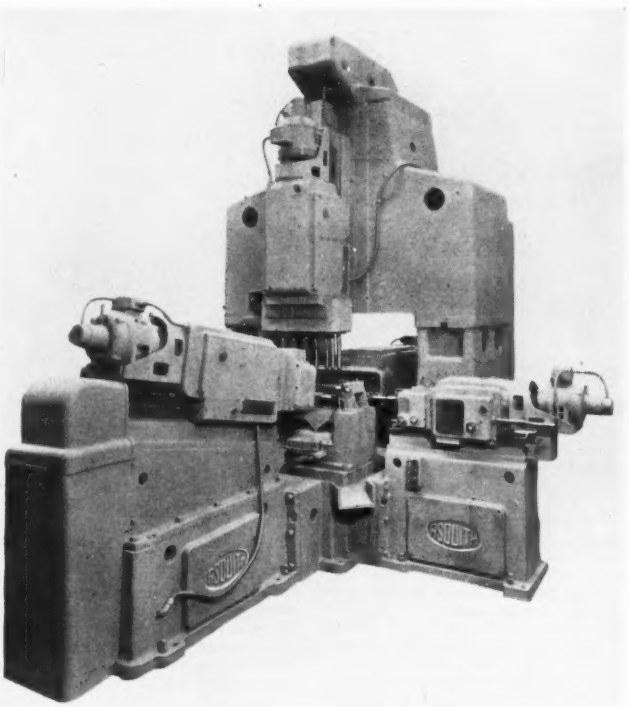


Fig. 40. Asquith four-way machine, with three heads tooled for tapping and one for counterboring

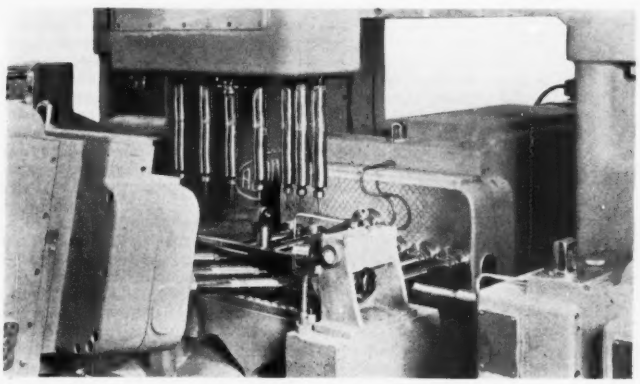


Fig. 41. The tooling on the machine shown in Fig. 40

Fig. 42. Cincinnati milling machine for finish machining the cylinder head joint face

The machine cycle for the four-cylinder head is similar, but there is a difference in indexing. A four cylinder head is mounted with Nos. 2 and 4 valve guide holes in line with Nos. 1 and 2 machine spindles. After the first advance and retraction of the table, the cross slide indexes to bring No. 1 valve guide hole into line with No. 2 spindle and No. 3 valve guide hole into line with No. 3 spindle. Change of the indexing stroke is effected by simple movement of a lever so that six- and four-cylinder heads can be machined alternately without any loss of time for change-over.

The push rod tubes are then inserted and the top end of each tube is expanded, following which the inlet and exhaust valve guides are pressed in at one stroke on a Mills Oilaulic press. The core plugs and the water tube are then assembled before the head is loaded into a special heavy-duty Cincinnati vertical, low-bed Hydromatic milling machine, see Fig. 42, for finish machining the joint face. The component is loaded by hand at the right-hand end of the table into a fixture which has automatic hydraulic clamping and which takes both sizes without any re-setting. A push button control operates the fixture and the table cycle. An 8½ in diameter face mill with 28 teeth is used. The depth of cut is $\frac{1}{32}$ in, the feed 50 in per minute, and the cutting speed 300 ft per minute. After the cut has been completed, the clamps are automatically released and the casting is automatically ejected on to the roller track while the table returns to the loading position.

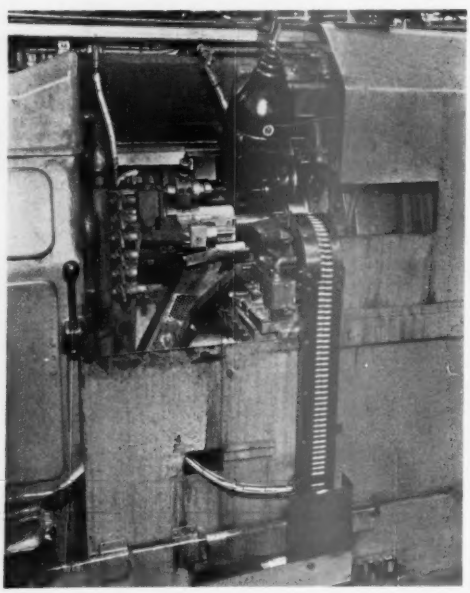


Fig. 43. The magazine feed tube for the second operation cycle on valve guides on a B.S.A. multi-spindle automatic

Rocker cover studs, rocker bracket studs and manifold studs are then screwed in with a Hi-cycle tool. The cylinder head is then air tested, washed and blown out. Finally, it is given a complete inspection before it is passed to the assembly station.

Valve guides

The valve guides are made from short cast iron sticks. These are first rough ground on a hopper fed Scrivener centreless grinder to a diameter suited to the collets of a B.S.A. six-spindle automatic machine that is used for the second operation. This machine has an interesting cycle. It is arranged for double indexing, so that on the first cycle the part is loaded at No. 1 station and machined at Nos. 3 and 5 stations. It is then ejected at No. 1 station and later re-loaded at No. 2 station and machined at Nos. 4 and 6 stations. Double indexing has been adopted to allow both ends of the component to be machined on the one machine.

The rough ground bars are loaded into a hopper at the right-hand side of the machine head, and with a feed tube leading to No. 1 station. At this station the casting is merely fed through to a stop and then gripped by the collet. At the third station the outer end is centre drilled, faced and chamfered, and at the fifth it is drilled half through and the outer diameter is turned for part of its length. The next indexing brings the component back to the first station where the collet opens and allows the part-machined guide to fall into a chute leading to a magazine feed tube at the front of the machine. The chute and the magazine feed tube are in such relation that the valve guide enters the feed tube with the machined portion facing the headstock of the machine.

From the magazine feed tube, which is shown in Fig. 43, the component is eventually fed to the collet at the second station. This collet incorporates a stop against which the faced end of the valve guide is pushed to give the correct longitudinal location. At the fourth station the outer end of the casting is drilled half through and the end is faced and chamfered, while at the sixth station the remainder of the outer diameter is turned and the drilled central hole is bored. An Offen boring bar with two tungsten carbide tools is used.

From the six-spindle machine the component is transferred to a Scrivener centreless grinder in which the outer diameter is finish ground to a diametral tolerance of 0·0005 in. The boring carried out on the six-spindle machine is held to a diametral tolerance of 0·001 in and leaves an allowance for fine boring. As the boring is carefully carried out in relation to the rough

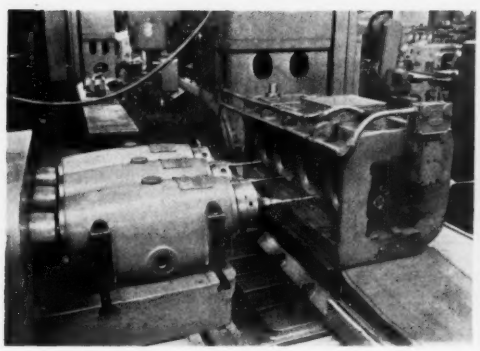


Fig. 44. Special Precimax fine borer for finishing valve elements

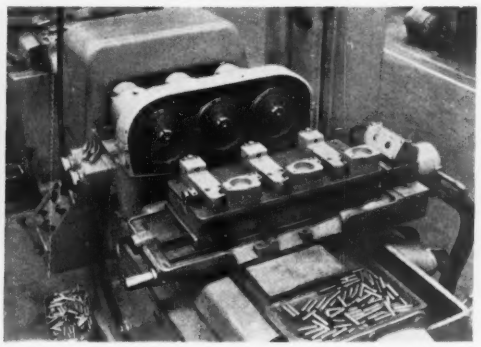


Fig. 45. Precimax fine borer for finishing valve guide bores

ground outer diameter, the finish ground outer diameter is concentric with the bored central hole within fine limits. This is important.

A special Precimax three-spindle fine borer is used for finishing the valve guide bore. On this machine the components are held in double diaphragm chucks. These chucks are relieved by hydraulic operating mechanism at the rear end of the spindles for loading and unloading. The boring bars are made of solid tungsten carbide, and the tools are brazed on to the ends of the bars. Each boring bar is held in a special holder which has fine adjustment. The exact adjustment of the bars is shown on dial indicators fixed on the machine. The set-up is illustrated in Fig. 45.

All three tool posts are carried on the top slide of an hydraulically-operated cross slide. This is to allow the tools to be offset 0·0065 in from centre during the forward stroke of the table. The tools do not cut on the forward stroke, but when the bars are at the innermost position, the top slide is automatically moved transversely to the boring position. Cutting then takes place on the return stroke. The table movement is interlocked with the cross slide position in such a manner that the table can be moved to the left, or boring position, only when the cross slide is in the rear position. Similarly, the table can be moved to the right only when the cross slide is in the foremost, or loading, position. At this operation 0·008 in of stock is removed from the bore diameter.

After the fine boring, the parts are inspected on a Sigma automatic multi-dimension checking and sorting machine, before they are transferred to the cylinder head roller track. The valve guide machining section runs parallel with and adjacent to the cylinder head line in such a position that the inspection of the guides is completed adjacent to the station on the cylinder head roller track at which assembly is carried out.

(To be continued)

FLUORESCENT CRACK DETECTION

UNDER the name Glo-mor, an improved fluorescent "ink" has been introduced by Manchester Oil Refinery, Trafford Park, Manchester, 17. The fluorescent powder is suspended in a liquid of extreme mobility which can penetrate cracks not normally visible to the unaided eye. In conjunction with this development a new portable hand lamp projecting an ultra-violet beam has been made by Hanovia Ltd., Slough. This lamp greatly increases the possibilities of the fluorescent method of crack detection because it enables parts to be examined in position on vehicles or machinery, whereas the fixed standard-lamp type of ultra-violet or "black light" source has necessitated the bringing of dismantled components to the work table.

Fluorescent crack detection has the advantage over the magnetic method in being applicable to non-ferrous metals, stainless steel or plastics. Cracks which are so fine as to be indistinguishable from ordinary surface scratches show up in brilliant green under the ultra-violet beam. The hand projector facilitates aiming the rays in any desired direction and a clear indication is given under average subdued general lighting conditions. The Hanovia Model 15 Fluorescence Lamp is provided with a pistol-type grip and weighs 2 lb. It is operated from the normal A.C. mains through a wall-mounted transformer, the running load being 125 watts (2 amp starting load). The complete equipment costs £30 and an alternative outfit for D.C. mains is available at the same price.

Fluorescent crack detection is carried out by dipping the part to be examined in the Glo-mor fluid, or brushing the suspected area or pouring a small quantity over it. A few moments drying off is allowed, followed by a quick rinse with a highly volatile solvent, when the specimen is ready for scanning under the ultra-violet beam. Apart from surface cracks, leaks in radiators and cracks or porosity in cylinder blocks can be traced by filling with the "ink" and observing the outer surfaces for the appearance of fluorescence under the beam. Faulty welds can be identified by painting the ink on one side and checking for fluorescence on the opposite face.

Magnetic crack detection methods are still required for the revelation of internal cracks which are not shown by the fluorescent technique in any material, magnetic or otherwise. Manchester Oil Refinery Ltd. also make Supramor magnetic "ink" in four grades based upon the magnetic powder content, and in black, white, red and yellow.

An informative leaflet dealing with these magnetic inks and the principles and methods of flaw detection has recently been issued by the manufacturers and will be supplied on application. (2023)

Plastics for Industry

A NEW brochure bearing the above title has been prepared by Resinoid and Mica Products Ltd., 28, Queen Anne's Gate, Westminster, London, S.W.1. In simple language it gives a comprehensive survey of plastics materials and of methods of manufacture. Not the least valuable of the information imparted is a chart indicating the comparative properties of the different types of plastics materials as regards hardness: tensile and impact strengths: resistance to heat, water, acids, alkalis, and solvents: machining and moulding qualities: colour range: and transparency. Copies of the brochure are available on request. (2020)

PLASTICS BODY CONSTRUCTION

Some Production Methods: General Conclusions

(*Continued from page* 229)

With Durestos, pressureless moulding yields a material which is only slightly inferior to that obtained by use of the vacuum process. However, it might well be preferred in view of the fact that the production equipment needed is less expensive. If the material is saturated with warm water before curing, it becomes soft, and can be consolidated by hand rolling to something approaching the fully compressed state. During the baking process, however, the fibres will spring back and lose their consolidation. This may be prevented by treating the soft Durestos sheets with a water-soluble, cold setting, resorcinol resin which penetrates the material and sets, thus locking the fibres in the compressed state. The subsequent cure is effected at temperatures as low as 75 deg C, and it shrinks the resorcinol, further consolidating the material. An over-night curing schedule of 16 hours has been used, but the time of cure depends on the temperature. Water is free to evaporate, as one side of the moulding is exposed to the air.

Vacuum moulding of Durestos, where an evacuated rubber bag applies pressure to the moulding, depends for its success upon the use of a satisfactory ventilating technique for extracting the water. Between the rubber bag and the plastics, a thick pad of a porous material is interposed. This pad is carefully vented to the vacuum pump and, under the conditions of temperature and pressure existing in the mould, removal of water is rapid and complete. Thick sections do not show any undue rise in temperature from the exothermic setting reaction. It is practicable, therefore to mould and cure shapes, the thickness of which varies greatly from place to place.

Sandwich construction

Sandwich materials with honeycomb cores have been manufactured at the Royal Aircraft Establishment by the vacuum bag process in the following way. The uncured felts that face the honeycomb are sized with a dilute solution of Formvar which prevents the adhesive from soaking into the Durestos and away from the joint. Then the sized surfaces are coated with a mixture of a modified phenolic adhesive, an organic solvent, and a polymerisable wetting agent. A critical factor is the viscosity of this mixture. When the assembly is heated, the solvent causes the glue to froth, and to partly fill the honeycomb tubes. The strength of the mixture is such that the froth breaks before setting, and the glue runs back down the tubes to form, at the joint, a fillet which subsequently hardens.

Moulding other materials

A few general principles apply to all low pressure moulding techniques, where plastics other than those cured by water condensation are used. Moulds can be made from plaster, timber or metal. Probably the best material, for producing more than about a dozen off, is aluminium sheet, panel beaten to the appropriate shape, and held on wooden formers. The requirements of a mould include rigidity, effective heat transfer and a good vacuum system. It may be necessary to include air release points if the moulding is a difficult shape to extract.

The vacuum system is best effected by having one or more vacuum leads to a channel around the rim of the mould. This should be at the highest point, as it is essential that the vacuum pipes are kept clear of the resin. It is important that they can be cleaned easily if they become blocked. Air leads for releasing the moulding are usually at the lowest point, and in order to prevent the plastics from blocking them, they should be covered with a sheet of Cellophane. The design of the mould must be such as to permit easy access for the operator. In addition, the application of the rubber bag must not cause layers of plastics to be knocked down. For heating, a basket of steam pipes, made so that the mould nestles into them, is satisfactory. Alternatively, electric elements may be positioned as close as possible to the charge to be cured. The heating systems should be well lagged to prevent waste.

The most useful general purpose separating agent is plain Cellophane. The moistureproof variety is undesirable as the lacquer is attacked by many of the resins. However, Cellophane is not very suitable for curved surfaces. Polyvinyl alcohol lightly plasticized with glycerine is an agent that may be used with most resins and it can be employed to cover vacuum bags. A spraying solution of 10 pints of polyvinyl alcohol, 90 pints of water and 2 pints of glycerine, is recommended.

With Nuron, one of the best separating agents is Manucol, which is the trade name for a sodium alginate. This is applied to the surfaces of the mould by painting or spraying on a cold aqueous solution with a little glycerine added. Colouring is necessary in order that patches left uncovered with parting agent may be detected. Wax is not a good parting agent to use on moulds with a highly polished surface when heat is applied for curing, as it does not adhere to the surface.

Although various vinyl resin bags have been employed, rubber bags are generally used for vacuum systems. When the moulds have double curvatures, the bags should be tailored. Uncured rubber containing vulcanizing agents can be obtained, and made into tailored bags by the following method. The mould is painted with two coats of a rubber adhesive in a naphtha solution, the first being allowed to dry before the second coating is given. When this is dry, the sheet is tailored to the mould, and carefully rolled onto the surface to eliminate air bubbles. Rubber strips, about 1 in wide, are used to seal the joints between the rubber pieces. The assembly is heated, usually at about 95 to 100 deg C, until it is cured.

Laying-up methods

Laying-up is assisted if guide marks are painted on the mould to indicate the position of the various pieces of cloth. It is sometimes helpful to make initial experiments on laying-up with cloth patterns and water or paste before beginning production. The most important requirement is that the cloth patterns should be designed to allow easy handling. In addition, considerations of strength will probably influence the laying-up pattern. With thick fabrics the edges are butted, but with fabrics of up to 0·01 in thick, they may be overlapped. Less accurate cutting is necessary when the overlapping method is employed. A liquid separating agent is easier to work on than Cellophane. It is important to eliminate pockets of air trapped between layers, as these can cause de-lamination during the curing process. One method of doing this is to roll the cloth up from both ends, and then to apply it to the mould, unrolling it from the centre, while at the same time working out the air.

Some practical applications

A method employed for the manufacture of components from glass

reinforced resin has been outlined in the description of the American car. However, for other applications different methods are suitable. The techniques used in the aircraft industry for the manufacture of radomes are interesting as they might well be modified for application to motor body construction. Radomes are the covers or containers for radar equipment. With modern very high speed aircraft, the aerodynamic loads on these components are extremely heavy.

The Bristol Aeroplane Co. Ltd. uses glass cloth in conjunction with a cold-setting polyester resin. Hollow plaster moulds, built up in segments, are employed. It is stated that about 20 components can be produced from one mould. The surface of the mould is smoothed with fine glass paper and impregnated, with paraffin-wax, in an oven. The wax adheres readily to the plaster, and acts as an excellent parting agent. It also provides a surface that can be scraped and polished prior to the application of glass cloth. Finally the impregnated mould is prepared for laying-up by painting it with another coat of molten paraffin-wax.

Three 36 in widths of loosely woven glass cloth, known as scrim, are used for each layer. The widths are oversewn at their selvedges to produce a butt-seam which offers the minimum protuberance on the contour of the work. It has been found that, with practice, no difficulty is experienced, by two operators working together, in covering the surface of the mould without the formation of wrinkles. Each successive layer of the cloth is laid with its seams at an angle to the previous ones, to equalize any stresses set up, and to cause the minimum interference with the radar transparency. The layers of cloth are held in position at the base by a series of staples that are driven into a wooden ring on which the mould is carried. Thickening at the base is effected by interleaving each lamination with strips of cloth, the widths of which are reduced with each successive layer; each strip is sewn to the previous layer of cloth.

When laying up is complete, the work is impregnated with Marco 28C resin which is slowly poured by an operator onto the top of the dome. Another operator controls the flow, permitting the viscous resin to advance slowly over the exterior of the work. A visual check is possible on the progress and penetration of the resin as, before applying the cloth, a series of lines are drawn with a blue wax pencil on the surface of the mould. Thus, when impregnation is complete, the glass cloth is rendered transparent, and these lines are visible over the entire surface.

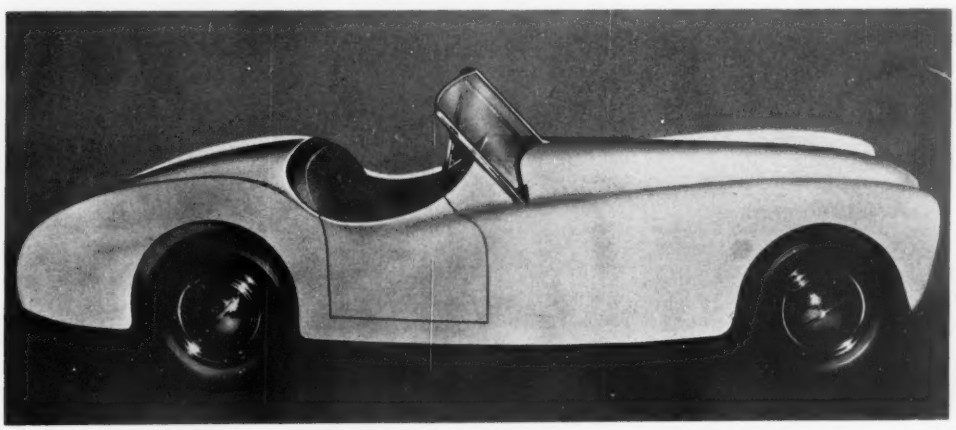
The setting time can be controlled by accelerators, and it is usually adjusted to give a laying-up time of about 4 hours. After the resin is set, the outer surface is scraped with a flat steel scraper until the glass cloth is exposed. The component is then painted with a thin coat of resin, mixed to provide a setting time of $1\frac{1}{2}$ hours. This gives the required surface finish on the work, and it minimizes absorbtion due to slight porosity of the original surface.

A saw is used to cut the radome around its periphery at the base, allowance being made for the final trimming operation which is carried out with a disc-sander. The component is removed from the mould by placing it with the bottom edge of the dome supported on packing strips in a low temperature oven. As the wax melts on the surface of the plaster, the mould is released without damage, and the radome can be removed. Finally the surface is rubbed down with a fine grade abrasive paper and spray-painted.

The de Havilland Aircraft Co. Ltd. has evolved a different technique. Their radomes are built on 16 S.W.G. panel-beaten sheet aluminium formers, upon which successive layers of resin-impregnated glass cloth are laid. The formers are then covered with a rubber bag. This is evacuated to produce pressure over the entire surface of the mould, and the assembly is baked to harden the resin.

The former is coated with a parting agent consisting of a solution in water of sodium alginate and ethylene glycol. Over this, strips of Cellophane are laid vertically, and held in position with short lengths of adhesive Cellophane tape. The glass cloth is impregnated with resin before being laid-up. Rubber rollers are used to assist impregnation.

Two operators are employed for the laying-up process. The layers of impregnated cloth are laid, one at a time, over the former, spread by hand, and worked with a warm iron to remove air bubbles and wrinkles. Each lamination consists of two sheets of cloth butted together at their margins on an irregular contour. The butting operation is carried out by lifting the cloth and trimming the edge with a knife. At each successive lamination, the contour of the joint-lines is varied to avoid concentrations of stress in the finished dome, and to spread the lines of resin-filling that are unavoidable at the joint. For a typical



A Vibrin polyester-glass fibre body made in America for the Singer 1500 chassis. The weight of the complete vehicle, it is claimed, is under 1,900 lb. The kerb weight of the S.M. 1500 saloon, with five gal fuel, was given as 2,618 lb in the *Autocar* road test, May 16th, 1952

radome, 17 laminations of 0·007 in thick cloth are built up to give a thickness of 0·10 in. At the base, additional interleavings of glass are employed for reinforcement.

The surface of the dome is then covered with Cellophane strips, and the assembly is shrouded in a rubber vacuum bag. Curing is carried out at a temperature of 140 deg C, and for this reason the bag is made of a heat-resisting rubber. In spite of this, it has been found that great care is necessary when removing the assembly from the oven as, when hot, the rubber is easily damaged. The bag is connected to the vacuum-line by three vents which are equi-spaced around the circumference. For the resin developed by this Company, the curing period is approximately 7 hours, but with Nuron resin, it can be reduced to 1 hour.

General conclusions

Some materials and production methods have been described, but these are not, by any means, the only ones that can be employed. An immense amount of development work is necessary before the production of plastics car bodies is a thoroughly sound economic proposition. Mechanization of the various handling processes would reduce labour costs, and this would no doubt be accompanied by the development of rapid-curing resins. With an increase in the demand for raw materials, and subsequent production on a sufficiently large scale, a further reduction in price can be visualized.

There is, at present, no reason why large-scale manufacturers of motor cars should change to plastics as their basic material. Indeed, there are very good reasons why they should not. However, world supplies of raw materials are so uncertain that the time may well come when serious consideration will be given to manufacturing at least some components from this new material.

Meanwhile, the use of plastics offers considerable advantages to small-scale manufacturers. The high cost of raw materials can be largely off-set by a reduction in tooling costs. Moreover, in some cases, less time and skill need be devoted to the manufacture than is the case with steel and, more particularly, with aluminium components. The non-corrosive nature of plastics is a noteworthy feature. Of importance to those interested in sports cars is the light weight of the material. Not only does this improve acceleration and fuel consumption, but it also gives greater stability on cornering, owing to the concentration of weight low down to give a favourable location of the centre of mass.

At first, there is likely to be a certain amount of sales resistance to the new material. However, a few well-planned demonstrations, and some successes in sporting events should overcome this. Caution is needed in connection with the ageing of plastics. More tests should be carried out in adverse climatic conditions. In connection with this, and with other investigations manufacturers may, of course, consult the National Research Establishments that have already done a lot of experimental work, the results of which are available to industry.

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CORRESPONDENCE

Correspondence on subjects of technical interest is invited. The name and address of the writer must be given, though not necessarily for publication. No responsibility is accepted for the opinions expressed.

CHROMIUM APPLIED INTERNALLY

SIR,—We read with interest the article in your May issue, "Chromium Plated Piston Rings," and from our considerable experience in the development and manufacture of our "Cromard" chromium plated cylinder liners, we can endorse very many of the points raised. However, we feel that the general statement that "Chromium plated cylinder liners were tried . . . and, in addition, experience showed that with a hard chromium surface in the bore, lubrication was unsatisfactory," is most misleading both to engineers and laymen.

Some chromium plated liners may have suffered, and we believe do suffer, from the inability to retain sufficient lubricant, and have proved to have non-wetting characteristics, but it must not be assumed that this is inevitable. Several manufacturers, and in particular Commer Cars Ltd., have proved otherwise with their full-length chromed bores. We ourselves have, as you know, successfully marketed for over six years the range of "Cromard" chromium plated steel cylinder liners, covering several hundred different engines, and we do not suffer unsatisfactory lubrication.

Fleet operators tell us that the improvement in performance and long life between overhauls amply repay the higher cost of the liners. Chromium plated piston rings actually cost just as much extra in proportion to other compression rings, as chromium plated liners compared with cast iron liners. The results are, as one would expect, also in proportion, going by the figures quoted in the above-mentioned article.

We get consistent reports of over 100,000 miles, with bore wear at a maximum of 0·001 in-0·0015 in. Users have claimed over 200,000 miles with similar results, sometimes with the same piston rings throughout. It is appreciated that one can always get figures to prove any point, but when these consistently show such results, one becomes happily convinced. Perhaps we should make it clear that these "Cromard" liners are marketed throughout the United Kingdom and in some thirty countries overseas in ever-increasing numbers.

A warning must be given, in fairness to both components. Never use chromium rings with chromium bores. This must be avoided at all costs, as the two like surfaces quickly play havoc with one another. The result then is that we both get a bad name.

BASIL de MATTOS,
Sales Manager,
Laystall Engineering Company, Ltd.

FLASHING DIRECTION INDICATORS

SIR,—As pioneers in Great Britain of direction indicators, we are strongly in favour of the recommendation made by the United Nations conference on Road and Motor Transport at the 1949 Geneva Convention, that flashing or winking lights for direction signals should be legalized in addition to the semaphore arm type. The clignoteur or flashing light is widely used on the Continent and in the U.S.A. and many other parts of the world, and there is no doubt in our minds that sets of clignoteurs fitted to the front and rear sides of vehicles are the finest method of direction signalling possible.

PAUL N. MATTON,
Managing Director,
Trico-Folberth Ltd.

TUBE MANUFACTURE

The Bronx Continuous Forming and Welding Machine

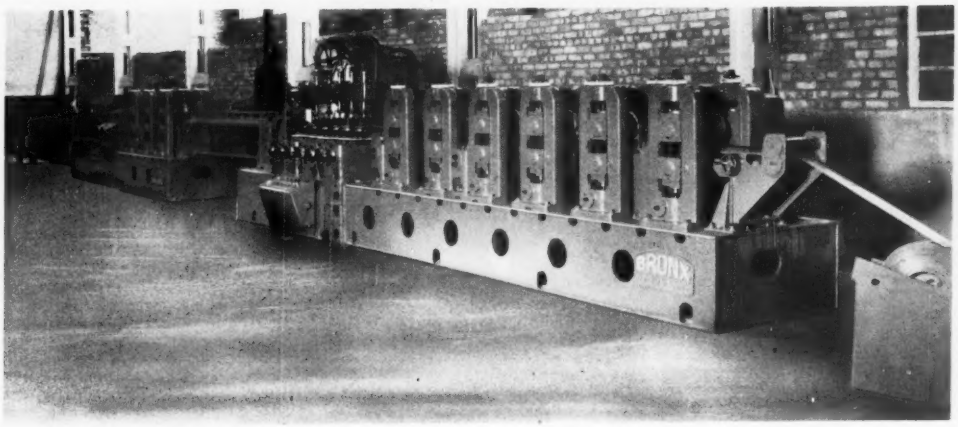


Fig. 1. The Bronx continuous tube forming and welding machine

A MACHINE for the continuous production of welded tube in diameters from $\frac{1}{2}$ in to $2\frac{1}{2}$ in in from 20 to 10 s.w.g. material has recently been completed by The Bronx Engineering Co., Ltd., Lye, Worcestershire. It has been devloped for a South American organization, and is shown in Fig. 1. The machine described in these notes incorporates an oxy-gas welding unit but alternatively an electric welding head can be supplied if desired.

Essentially the machine comprises five principal units. They are:—

(1) Forming unit.
(2) Oxy-acetylene welding unit.
(3) Sizing and straightening unit.
(4) Flying cut-off.
(5) Run-out and discharge table.

Ancillary units are interposed between the major items. They comprise a tube guide immediately before the welding unit, a weld trimmer after the welding unit, and a discharge roll at the entry end of run-out and discharge table.

Six horizontal forming rolls, preceded by a guide bracket and supporting rollers for the strip feed, comprise the forming unit of this machine. The forming roll spindles are each supported at the inner end by twin tapered roller bearings. Hyatt type rollers are used for the outer bearings.

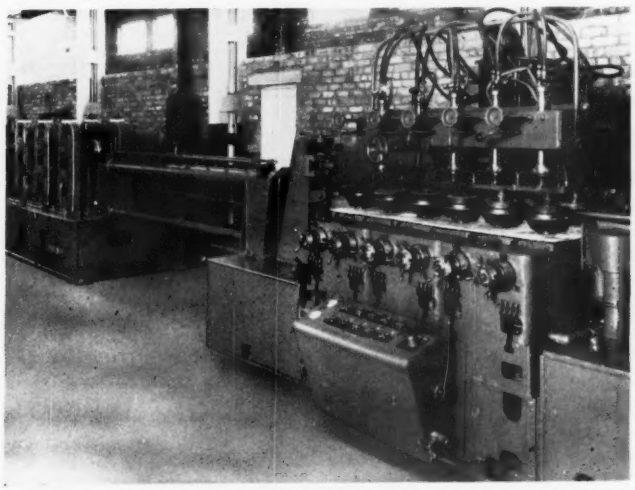


Fig. 2. The welding unit and, to the left, a portion of the sizing roll unit

On either side of the horizontal forming roll in this section of the machine there is a set of vertical rolls. The outer of these gives the final contour to the tube prior to welding. All rolls have top and bottom adjustment. For setting the top roll there is a micrometer scale incorporated on the top of each bearing for both the inboard bearings and the outboard bearings in their pedestals.

On leaving the forming unit, the strip is in the form of a tube which goes into the welding unit through a tube guide. This guide consists of a blade which runs between the tube's shutting edges to ensure that the joint is kept in line beneath the welding head. From the guide, the tube passes between six sets of laterally-adjustable rolls. Each roll is water cooled. The cooling water is supplied through branch pipes under the machine and leading to the hollow roll spindles. The cooling water passes up through the spindle and is fed, via two small branch pipes, into the cup formed by the hollowed-out roll. It subsequently overflows through an annulus in the centre of the roll and thence into a trough.

Five FH blowpipe bodies are mounted on the welding unit, see Fig. 2. Each carries a flat head with a multiple nozzle. These five heads are so arranged that the first three carry 53 4BA thread nozzles set in two rows. In the fourth head there are 75 nozzles set in two rows which converge in the direction of the travelling tube. These four sets of nozzles are for heating only. The fifth and final set is the actual welding head. It carries 41 nozzles in a single row.

Individual height and lateral adjust-

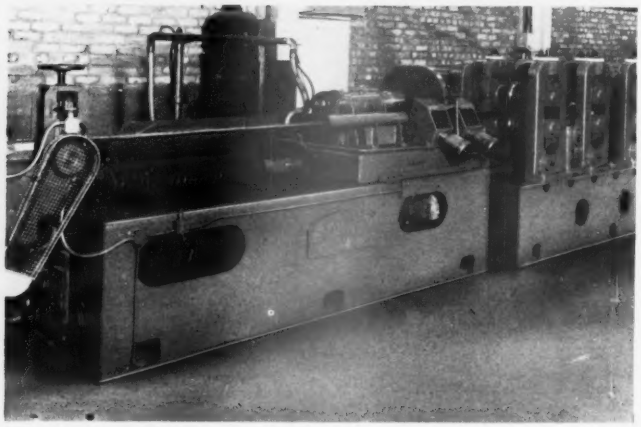


Fig. 3. The flying cut-off unit

ment are provided for the nozzle heads by mounting them on a beam centrally disposed over the table. Vertical adjustment of the heads is effected by means of control levers that actuate an eccentric. There is an individual control lever for each head. Lateral movement is provided by a worm-nut mechanism with five small handwheels. The beam is supported by a saddle riding on a pillar behind the unit. It is set to the correct height against a stop which is adjusted by means of a handwheel at the front of the welding unit. The beam is counter-balanced, and is lowered to the working position by an air cylinder located below the balance weights and controlled by a hand-operated air valve. When a foot-operated stop is released, the balance weights quickly lift the welding head clear of the work.

The blowpipe shanks and the nozzle units for heating and welding are cooled by water that passes down around the blowpipes into the nozzle heads. This water overflows through small diameter tubes into the cups of the rolls. Immediately under the portion of the tube that is being heated and welded, there is a slotted channel faced with asbestos. The slot is the entry for an exhaust duct running along the centre of the welding unit.

In the oxy-gas type machine the gas supplies to the welding and heating heads are controlled from a panel situated in front of the unit. The panel carries oxygen and acetylene pressure gauges, the oxygen regulator control and the valve control for the gases to each blowpipe. For trial purposes, the acetylene regulator was mounted on a separate board with the acetylene manifold and the supply was taken from two banks of ten cylinders. It is understood, however, that when the machine is put into operation, generated acetylene, subsequently compressed to provide a minimum outlet pressure of 6 p.s.i., will be used. The welding equipment has been designed and supplied by British Oxygen Co., Ltd. Test runs on 1¼ in diameter × 14 s.w.g. material gave welds with 100 per cent penetration and good fusion. Pieces from sample welds were subjected to 90 per cent bend tests without causing any signs of cracking.

Weld trimming is effected by a tool adjustably mounted in a tool post. The cutting face is ground slightly concave to accommodate different diameters and support is provided by a roller immediately under the tube. Trimming is effected at the entry end of the sizing and straightening unit. This unit comprises three sets of rolls. Following the sizing and straightening rolls there is a flying cut-off, see Fig. 3. This has a pneumatically-operated return ram and tube clamp. Cutting off is effected by an abrasive wheel, 16 in diameter and running at 3,600 r.p.m. Its traverse across the tube is arranged by a pick-up wheel running up an inclined ramp as the cut-off head travels down the length of the unit. This arrangement gives a rocking motion to the cut-off head. The speed of travel of the cut-off head is synchronized with that of the tube by the operation of pneumatic clamps on either side of the cut-off wheel. An adjustable limit switch on the discharge table allows the length of the cut tube to be set at any required length between 10 ft and 20 ft.

The discharge pinch roll runs at a higher speed than the main rolls, so that when the tube is fully parted-off the free portion is accelerated to increase the gap between it and the following section, and also to propel it the full length of the discharge table, which is shown in Fig. 4. From the discharge table it is released on to a cooling rack by pneumatically-operated triggers.

A 25 h.p. D.C. variable speed motor running at 500 to 1,500 r.p.m. is used for driving the main rolls. The drive is by vee belts to the machine and thence through chain couplings to the forming, sizing and straightening rolls. A separate motor drives the exhaust fan. There is also a separate motor, 15 h.p. at 3,600 r.p.m., for driving the cut-off wheel. The drive to the cut-off spindle is by a special flat belt. It is interesting in that it is so arranged that there is no bending stress on the spindle which runs in Hyatt type bearings.

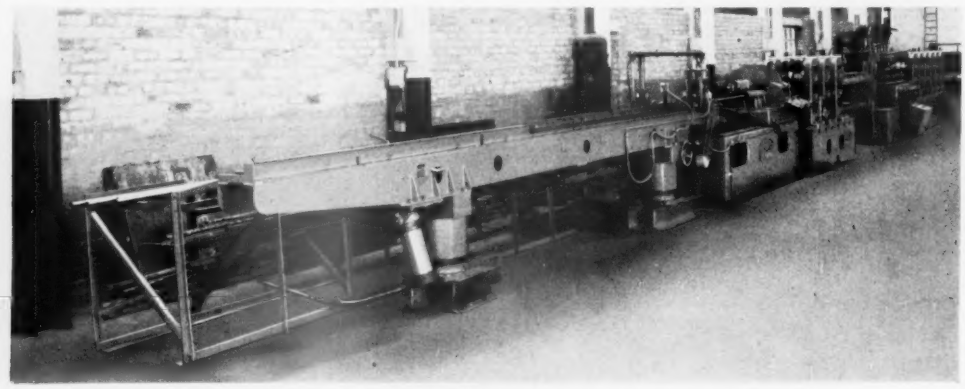


Fig. 4. The discharge table of the Bronx continuous tube forming and welding machine

BODY DRAUGHTSMANSHIP

A Survey of the Principal Drawings in the I.B.C.A.M. Contest

TO stimulate improvements in the design of bodywork for private cars, commercial and public service vehicles, the Institute of British Carriage and Automobile Manufacturers, in conjunction with the Worshipful Company of Coachmakers, organize annually a series of drawing competitions which invariably produce some interesting ideas and some excellent draughtsmanship. The Society of Motor Manufacturers and Traders are also interested, and amongst the drawings submitted for consideration this year were some excellent examples.

To one who has studied these competitions over a number of years, the work of certain competitors is outstanding, and in this connection it is interesting to note that a prizewinner of previous years will time and again be successful, and such is the case this year. For the current year, the competitions embraced all types of private and passenger-carrying vehicles. The private car classes range from drawings featuring the limousine to those dealing with open sports two-seaters. For the heavier vehicles there was a class for a single-deck bus design, and also one for a mobile office, and the prizes in each case were of a standard which should ensure a ready response.

All classes were well represented at the exhibition of competitors' work held in London and the standard of draughtsmanship was of the high order one has come to expect at this event. Mention may also be made of the two handicraft competitions run concurrently. For woodworkers the task was a quarter-size framework for a passenger coach sliding door, while for metalworkers it was a hand-beaten used ticket box in aluminium. Both competitions were well supported and the examples exhibited provided ample evidence that skill in the crafts is not losing its cunning.

Competition No. 1

This competition was open to persons of British nationality, without age limit, and was for a coloured drawing and also a general arrangement drawing showing side elevation and half-plan of a limousine with occasional seats. The coloured drawing was required to be to a scale of $\frac{1}{4}$ in to the foot, and a three-quarter front view was specified. It was left to the competitor whether the work was hand-brushed or finished by mechanical means. The general arrangement drawing was required to a scale of $1\frac{1}{2}$ in to the foot and was to provide essential information for checking practicability. The regulations for this competition made a special point of the originality shown by competitors in the incorporation of interior equipment.

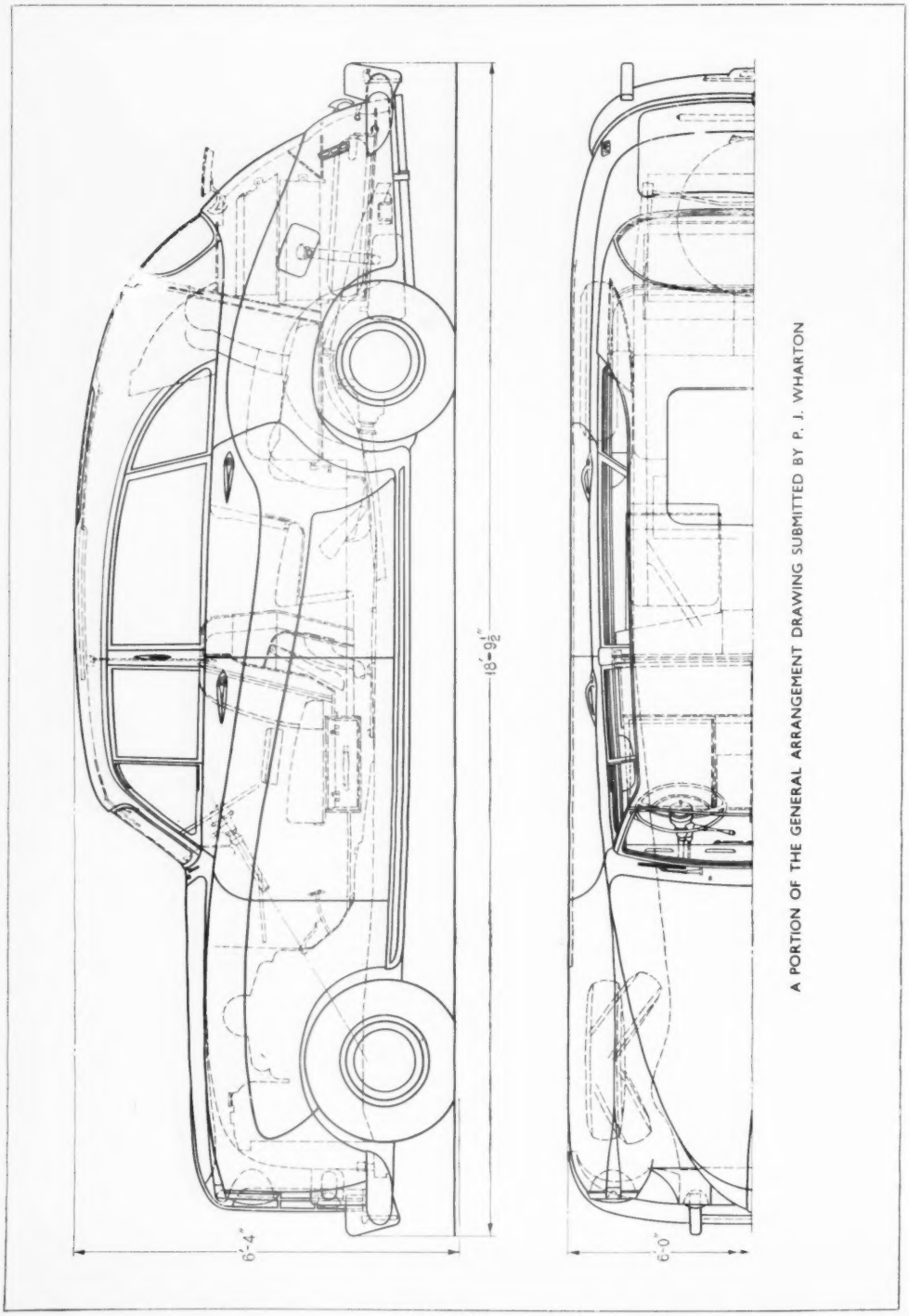
The first prize of £50 and the Company's medal was awarded to P. J. Wharton, who thus for the third successive occasion is the winner of this class. As one has come to expect from this competitor, his work is outstanding both from the point of view of draughtsmanship and also in design considerations. A reproduction of the coloured drawing which was submitted, together with a portion of the general arrangement drawing, is included in this review, and dealing first with external considerations, it will be appreciated that the design is fully in keeping with modern thought, particularly when one considers that the subject is a limousine body.

An outstanding feature, and one which is not generally associated with limousine coachwork, is the full flow wing uniting both front and rear components and falling as it passes across the doors. It is interesting to note that this competitor does not use a detachable panel to partly conceal the rear wheel. The depth of the full flow wing as it passes across the doors is relieved by swaging, harmonizing with the general form of the wing and giving an opportunity for the introduction of a second colour.

In a rear view which is included with the coloured drawing, but is not reproduced in our illustration, it is noted that the wing line is turned across the back panel and introduces a roll-in treatment which gives relief to what would otherwise be an orthodox rear styling. The front wings have built-in head lamps, and fog lamps are housed in recesses to form a sliding fit on the bumper over-rider to obviate damage to the wing catwalk.

Regarding the bonnet, this is mounted on spring-loaded concealed hinges at the scuttle end and is locked from the instrument panel. The body itself is of four-door, six-light form, the doors being hinged at the front, and push-button handles are used. Below the swage line on the wing, the front door hinge line is vertical, thus facilitating hinging and door operation, but above this wing line the pillar is inclined at a fairly sharp angle and accommodates a curved screen. Ventilating panels swivelling through 180 deg are fitted at the forward ends of the front door windows, the remaining

A reproduction of the coloured drawing securing first prize in Competition No. 1



A PORTION OF THE GENERAL ARRANGEMENT DRAWING SUBMITTED BY P. J. WHARTON

Unusual design of limousine by C. G. Neale

portion of the window being equipped to drop.

Concerning the interior arrangement, and dealing first with the front compartment, an interesting point is the way in which the front seat cushion and squab are divided, and the near-side cushion may be removed and secured beneath the instrument board by means of clips provided on the toe board and scuttle side. The near-side section of the seat squab may then be folded down to form a luggage platform, and both fixed and folding squab boards are faced with polished wood and fitted with chromium - plated rubbing strips and strap staples. In addition, the hinged squab board is equipped with flush-folding, chromium-plated guard rails which prevent luggage from sliding either on to the door or the driver's seat. Beneath the front seat board two suit cases are fitted into recesses, on at each side, and a tool drawer is fitted between the recesses.

Adjustable arm rests are fitted to both doors and "Quicklift" mechanism is used for the window of the off-side door, large cupboards with hinged lids being arranged in each door. The off-side cupboard is intended to contain the chauffeur's equipment, such as cleaning material, whilst the near-side cupboard is to be lined with waterproof material, making it suitable for storing such items as umbrellas. In this design the step boards are concealed by the doors, and these boards have chromium-plated treads, the body still being recessed locally to give additional toe room.

Considerable thought has been devoted to the layout of the division, and the upper facia is divided into four compartments, each with a hinged lid. The outer compartment at each side is fitted up as a companion, one for a lady and one for a gentleman, the two inner compartments being available for books, sandwich boxes, and so on. In the centre the facia accommodates a clock, ash-tray and cigar lighter, and below this is a cupboard containing decanters and glasses. The door of this cupboard may be hinged downwards to form a table and is fitted with hinged side flaps which when folded out, extend the width of this table, although it is only possible to use the extension when the occasional seats are not in use.

Below the cupboard is a steel-lined drawer fitted with a Yale lock, this being suitable for private papers and will be particularly appreciated when touring. The lower portion of the cabinet accommodates the radio set, with a speaker mounted behind a grille, while grab handles are fitted to the upper division pillars and also heater grilles. Step lights are mounted in the lower portion of the pillars.

This competitor appreciates that some customers may require a different occasional seat layout, and he therefore shows the main interior sketch with two separate occasional seats and a centre cabinet as described, but he also shows two alternative arrangements which provide full width occasional seats, making in the one case a three-seater scheme, whilst in the third arrangement the full width seat is equipped with side and centre arm rests, giving two extremely comfortable occasional seats. When these alternative arrangements are used, the radio set is housed in the body and an extension speaker is mounted in the centre of the division facia. A cigar lighter and ash-tray are fitted above the speaker grille, and the remainder of the facia follows the scheme already described, except that a clock can no longer be incorporated in the division facia and may be arranged in the centre of the division roof rail.

The rear seats are adjustable and are trimmed with head and knee rolls, head rests being arranged in each quarter panel. The offside arm rest contains radio controls, beneath which are switches for the electrically-operated division, rear blind and roof light. Duplicate switches are arranged in a panel in the near-side arm rest and match the radio controls, whilst the centre folding arm rest is fitted with a glove box. The rear seats are provided with two hassock-type foot rests which fold into the floor and are concealed when not in use.

Rear door glasses are electrically operated and control switches are mounted in a fillet. The door locks have remote controls and parcel lockers with hinged lids are arranged in the lower portions of the doors. Sliding Purdah glass quarter lights are used and are arranged in chromium-plated latticed frames inside the main quarter glass. The head lining is recessed above the rear seats and ash-trays are provided in the quarter fillets. Roof lights are fitted in each of the quarter panels, and for the assistance of the rear seat passengers there are swivelling rope pulls above the quarter lights, these pulls having polished wood grips. Purdah glass is also used as a blind for the rear light.

The second prize of £25 and the Company's medal was awarded to C. G. Neale, whose coloured drawing in maroon showed a distinctive and original design. In particular, the upper door pillar arrangement is unusual and there will, no doubt, be many who disagree with the lines which have been followed.

Reference to the reproduction of the coloured drawing will give an idea of the peculiar contradiction in upper pillar lines which this design features, and starting with the screen pillar, this above the waist has a rearward inclination, whilst the equivalent portion of the shut pillar of the same door has a forward inclination. This in itself would be perfectly satisfactory, but immediately behind the front door shut pillar, there is a vertical metal channel which is repeated at the rear door hinge pillar. Behind this the rearward edge of the quarter light has a rearward inclination, approximately of the same angle as the screen pillar, and it is

difficult to see why this competitor has chosen these particular lines.

Apart from the upper pillar arrangement, the body contour follows accepted modern principles, the front wing passing across the side panels at waist height to run towards the rear following the boot line. As is usual, the head lamps, horn grilles and side lamps are accommodated in the forward panels of the front wings; and it is to be noted that the side lamps embody flash turn indicators.

The depth of the wing outer panels is relieved by a swaged line which passes over the wing above the side lamp, and at the rear is downswept following the boot line to terminate at the bumper end.

The windscreen is curved and a curved rear light extends to the full width of the rear panel, and is carried on to the quarters. Hinged fairings partly conceal the rear wheels, and the lower portion of the doors and body side panels are outswept. In his arrangement drawing this competitor shows excellent draughtsmanship, and a number of interior sketches show the general layout of the front and rear compartments, the sketches being in perspective and giving all the information that may be required.

One of the features of this design is the Perspex roof panel above the occasional seats, and a sliding section passing over the front seats can be used to blank off this transparent roof panel. There is a retractable external visor for use when driving for any length of time against low sun, this visor also being housed in the front roof panel.

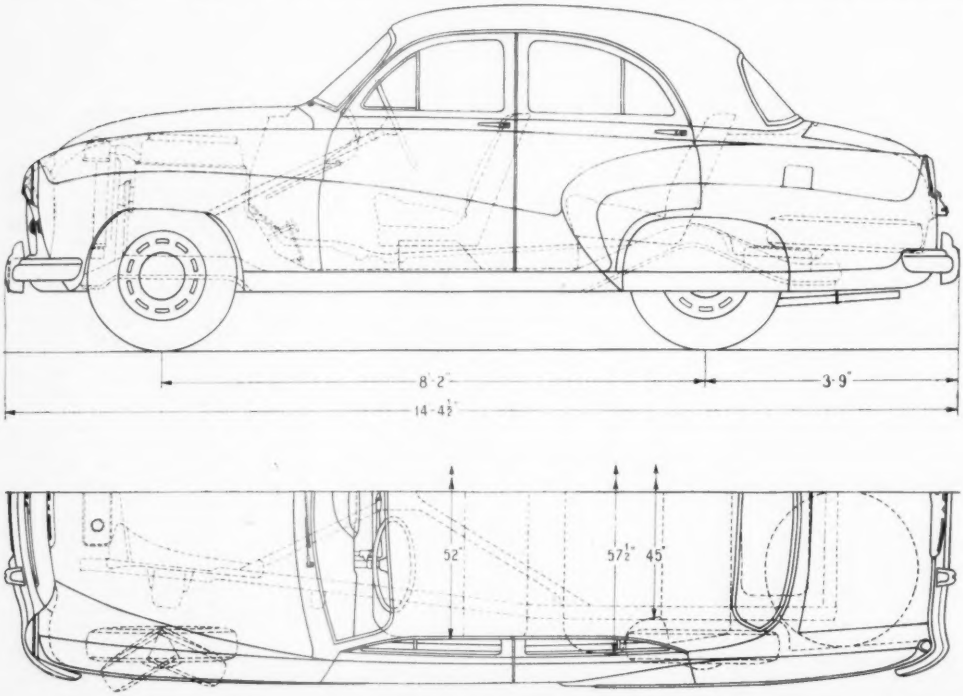
The front doors are hinged on their forward edges, the door line below the waist being practically vertical, whilst the rear doors are hinged on the rear pillars, and are so arranged that the wheel arches do not restrict space when entering. The door windows are electrically-operated and the unusual pillar arrangement gives an inverted swivelling ventilation panel between the front and rear door windows, and is claimed to be a means of giving ventilation to the driver without introducing a blind spot at the front pillars.

Of the seating arrangement used in this design, this competitor gives fairly complete details of the materials to be used, and the one-piece front seat is trimmed with grey hide over Dunlopillo overlays on coil springs. The rear seats follow similar lines and the whole effect is relieved by maroon piping, a similar scheme being used on the doors. In the front compartment, the instrument board has a tool drawer on the near side, a beneath this is a map tray, whilst a map light is conveniently arranged above. The glove box, which is above the tool tray, has a disappearing lid, whilst the centre of the instrument panel contains the radio set, which is of pre-selector pattern.

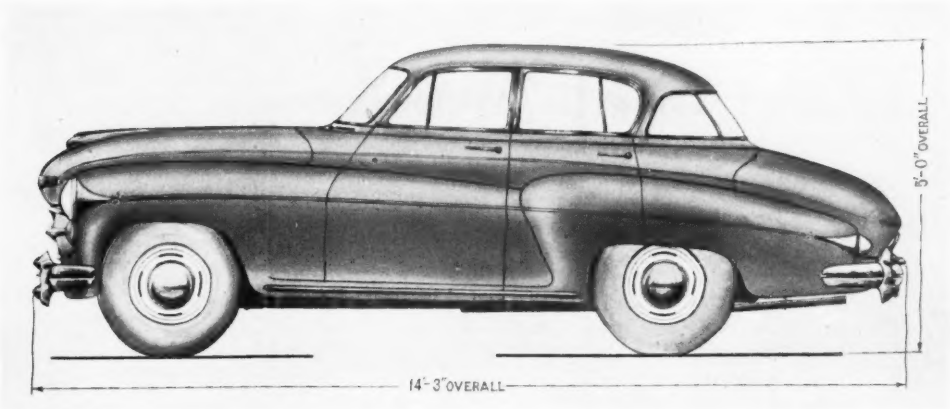
De-misting air ducts are arranged at each side and the essential instruments are contained in a panel immediately in front of the driver. Switches for auxiliary items of equipment are grouped in the centre of the instrument panel beneath the radio set, and also at the right-hand side. In the off-side front door there is a compartment with a drop lid for the housing of cleaning materials, and this competitor uses arm rests on the door with a combined door pull, the centre of the arm rest being recessed for this purpose. The division between front and rear compartments contains two forward facing occasional seats, and there is a central cabinet, the upper part of which is devoted to cocktail equipment and contains three decanters and six glasses, whilst a lower compartment is for the storage of food and includes picnic box and thermos tea jug. A single central lock fastens the double doors of the cocktail cabinet and the drop door of the food compartment.

Above each of the occasional seats the division facia contains a compartment for the accommodation of the tea service on the near side, and for cutlery and table linen on the off-side, and in each case the compartment lid can be used as a small table. The inner panels of the rear doors contain storage for maps, magazines and similar articles, a large portion of the inner panel being hinged at the base.

The rear seats embody a device which gives adjustment for squab angle, a handle for this purpose being



Design securing first prize in Competition No. 2



Reproduction of the coloured drawing securing second prize in Competition No. 2

arranged in the centre of the heel board. At each side this heel board contains grilles for the air conditioning installation, and the step light is situated at the ends of the heel board. There is a folding centre arm rest, which incorporates radio controls, the Radiomobile set operating twin speakers which are fitted flush in the parcel shelf behind the rear squab. The usual controls for heater, division and blind are recessed into the forward faces of the arm rests, and a point of interest is the fact that twin, electrically-operated rear blinds can expose any desired width of the rear light.

There is a capacious boot and access to this compartment is by means of an elevating lid which comprises most of the boot panel, both upper and rear. The boot contains the spare wheel which is mounted vertically on the offside, and another small point which is worthy of note is the use of a single central screen wiper and screen washing equipment on the large back light. The centre section of this back light is composed of double glass with internally-heated air space to avoid misting.

Whilst some students might disagree with this competitor's body design, it is very obvious that he has given considerable thought to the equipment of the body, and some of the ideas which are used are well worthy of consideration, and it is felt that many of the smaller items such as the single lock for the three doors of the division cabinet, and the use of screen equipment for the rear light, are points which will appeal to the many and did undoubtedly influence the judges.

The third prize was awarded jointly to N. Henderson and R. Haynes, each of whom received £10 and the Company's medal.

Competition No. 2

This competition was open to persons of British nationality, without age limit, and was for a layout drawing in ink, to a scale of 1½ in to the foot. The type of body was to be a four-door, four-light saloon of metal construction, suitable for quantity production, and in addition to the elevation, half-plan, half-front and half-rear views were required. The competitors were required to give special attention to their design's suitability for large-scale production, economy of tooling costs and practicability for knock-down shipment and assembly.

The first prize of £75 and the Company's medal was awarded to L. L. Reeves, whose design followed conventional lines. The usual full flow front wing is utilized and on the rear door this wing disappears as a separate unit, and a normal wing of similar form covers the rear wheels. In this case also the depth of the wing side panel is relieved by swaging which starts from above the head lamp, recessed into the front of the wing, and follows a falling line to merge into the rear wing. Again, this treatment makes possible an attractive colour scheme, and is is noted that a similar swaged line is used on the rear wing.

Front and rear door windows are symmetrically arranged about the centre pillar and each has a swivelling ventilation panel. There is a large back light which, in common with the windscreen, has curved glass. Both front and rear doors are hinged on the forward pillars, and the lid giving access to the commodious boot is hinged at the top. The spare wheel is mounted on the boot floor to the near side, and no supplementary floor above the wheel is shown. There appears to be ample head room in this design, the head room above the front seat cushion when compressed being 38½ in, whilst the equivalent dimension for the rear seat is 36 in. There is a full width front seat and it is to be observed that the forward location of the rear seat avoids the encroachment of the wheel arch on the cushion.

The second prize of £37 10s. and the Company's medal was awarded to L. J. Stevenson. The drawing submitted by this competitor was noticeably good and his design is outstanding for the almost entire absence of blind panels in the upper structure. For example, following the screen and door windows the rear light extends on to the quarter panels and reaches the door pillar, thus the usual blind quarter is completely eliminated.

Concerning the general body design, full-flow wings are used, but there is a distinct break in plan between the front and rear wings, the front wing terminating as its line passes on to the rear door. At this point the rear wing emerges and is continued rearward to blend in with the boot panels although still appearing as a separate but harmonious component. In place of the usual swaged line on the wing, this competitor uses a chromium-plated moulding which at the front grows out of the head lamp fairing and continues across both front and rear wings to meet the rear lamp fairing.

The bonnet panels are of well-rounded form, both in elevation and plan, and the nose of the bonnet extends forward beyond the rather heavy radiator grille. The bumpers and over-riders are of heavy design but they conform to the general principles of this design and do not appear out of place. Both doors are hinged on their forward pillars and access to the boot is by means of a lid which in actual fact constitutes the entire upper and side panels of the boot itself.

There is no detachable panel on the rear wing to give access to the rear wheel, but the wing valance line coincides with the wheel rim and no difficulty would be experienced in removing the wheel when the modern system of jacking under the frame is employed, the spring going to its full rebound position.

The interior layout follows conventional lines, the front seat being in one piece and giving ample accommodation for three persons abreast. The rear seat, being positioned well forward of the rear axle, is not seriously affected by the wheel arches and has the usual

centre and side arm rests, the side arm rests being attached to the doors which they overlap. The low floor has a central tunnel and is devoid of other obstructions. In the layout of the instrument facia, a symmetrical scheme is employed, the flat Gothic arch-shaped door on the near-side, which gives access to the cubby box, being reproduced on the off-side where it contains the essential instruments and switches. In the centre is mounted the radio set, complete with loud speaker grille, and beneath the controls there are two quadrants to adjust the degree of heat which is admitted to the body through the air conditioning equipment.

A second drawing gives general constructional information and shows that the bonnet is hinged at the rear and is supported when raised by a side arm. The doors contain the usual full drop windows working on parallel arm mechanisms, and the triangular panel in the front doors is made to swivel in the usual way for ventilation purposes.

The spare wheel is placed in a horizontal position on the boot floor and there is no supplementary floor above it. As in most cases, this spare wheel is located on the near side where its weight tends to balance that of the driver. This second drawing contains a number of small sections giving very complete information concerning constructional items, and the entire work is tinted in yellow for the body and a pale shade of red for chassis items, thus giving a very clear conception of the functions performed by the chassis in relation to the coachwork.

This competitor has gone to considerable pains to clarify the "knock-down" aspect of this body, and in addition to the two drawings dealing with the design and constructional features he includes a third sheet showing the panels and components for knock-down shipment. This third sheet represents a most important key to the general assembly of this quite interesting body, and it is so laid out that there is little difficulty in getting a very clear idea of the sequence of assembly. It is evident, for example, that starting from the front of the car and dealing with the side panel, the front wing unit terminates at the front door hinge line, followed of course by the two doors of which the rear door carries the forward portion of the rear wing. Behind this and separate from the body panels is the rear wing, and as previously mentioned, the boot lid, since it constitutes the main upper panels of the boot, cannot be included with the rear wing.

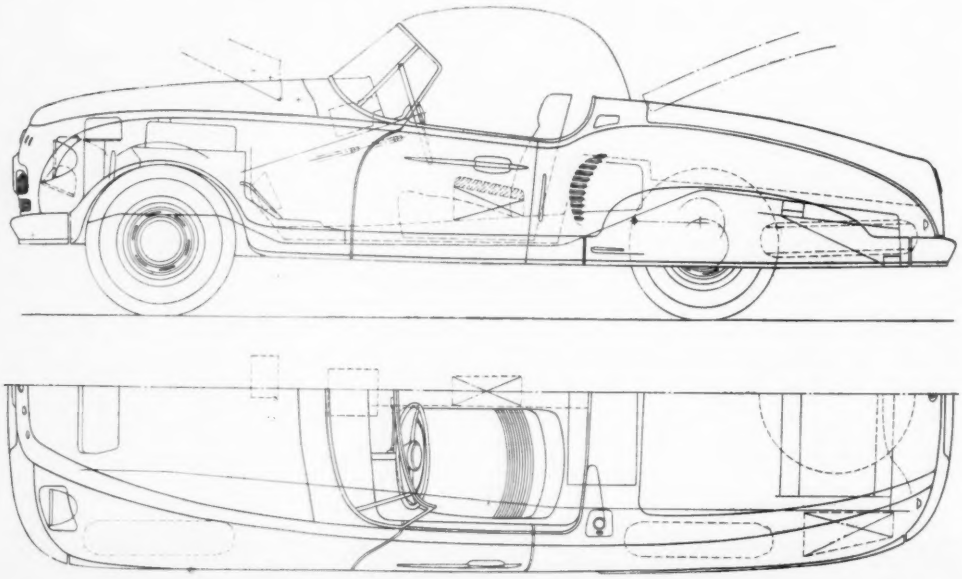
The body floor is composed of three sections, the front portion of which includes the toe board and gearbox cover, whilst the portion beneath the front seats extends rearwards to include the rear seat pan. Behind this, there is of course the boot floor, and all units are liberally swaged in opposing directions to prevent deflection under load.

The upper door frames are assembled as complete units and shaped in that form, these upper frames containing the swivelling ventilation panels and have their glass runs extending to the full depth to pick up suitable points of attachment in the lower door construction. As shipped, these window frames are complete with their glasses.

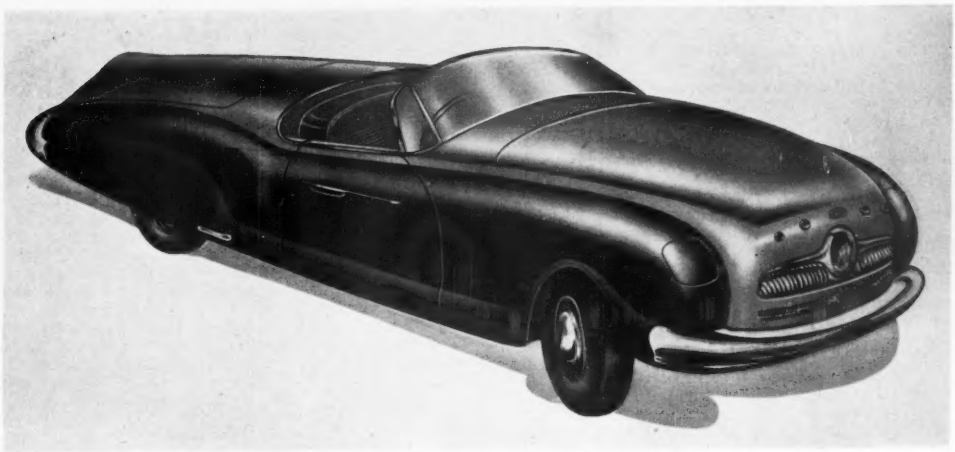
In the general design drawings, appropriate fittings are only shown diagrammatically, for it is felt that their functions and construction are well known. The competitor gives a schedule enumerating these appropriate fittings, and it is noted that amongst the items included are Schonitzer door locks, which of course are made in this country by Wilmot-Breeden. Other door furniture is by the same manufacturer, and the tubular seat frames are produced by Cox and Co.

It is intended that when shipped the body components should include trimming and insulation materials, sealing compounds, and rubber sections for mounting and sealing, together with all fittings such as bolts, nuts, and so on. Also, that the paint, rust-proofing treatments, cleaning and polishing materials and replacement parts should be shipped in bulk. It is pointed out also that the design shown is for a de luxe model, and for a standard or utility model certain items can be deleted without serious detriment to the general style. These include the lamp motifs, the air intake motif, bumpers and various interior fittings which if not deleted, could be simplified. Certain other refinements, such as the radio, heater and similar items could also be omitted. The design further allows for the body to be used below the waist line for a folding-top open car, or alternatively a "hard top" model, leaving the side windows and their frames intact, with the possible modification to the shape of the frame over the rear door ventilator.

The third prize of £15 and the Company's medal was awarded to D. V. Williams.



The design gaining first prize in Competition No. 3



Reproduction of the two-seater by A. H. Levene

Competition No. 3

This competition was open to students of any technical school or those employed in British workshops under the age of 21, and was for an outline drawing of an open sports two- or three-seater, on a wheelbase of 7 ft 9 in and within an overall length of 13 ft 6 in. The drawing was required to a scale of 1½ in to the foot and could be in ink or pencil, and was to show the side elevation, half-front, half-rear and half-plan views. The organizers did not supply a coachbuilder's drawing, and it was left to the competitors to decide on their chassis within the specified dimensions.

The first prize of £20 was awarded to A. H. Levene, who in addition to his general arrangement drawing, submitted a coloured drawing featuring a three-qurater front view. This competitor showed a two-seater body, both front seats being separate, and a compartment being arranged between the seats to house binoculars and similar items. The lid of this central compartment has a sponge-rubber top to form an arm rest.

In the design, the full-flow wing is used, contoured at the sides of the cockpit to harmonize with the line of the waist rail and sweeping upwards behind this to merge into the rear wing line. Concealing the rear tyre there is a detachable panel in the rear wing, which has a release handle at the front end, and the wing design is such that at both front and rear, the bumpers form a continuous line. An alligator bonnet is used, hinging upwards from the scuttle end, and there is a bonnet release button in the centre of the radiator cowling. Access to the boot, in which the spare wheel is housed, is by a large lid occupying most of the top panel, this lid being spring assisted. The boot lid release button is situated immediately above the rear upper plate. The luggage capacity of the boot is approximately 16 cu ft, and the boot floor contains boxes sunk in the floor for the housing of small road tools.

Cubby boxes are provided in both doors and are large enough to house standard size vacuum flasks, sandwich boxes and articles of similar nature. The doors are hinged on their forward pillars and the handles are embodied in the chromium plated motif which is used as a form of decoration. This competitor points out that the fixed curved screen which is illustrated, has very full curvature and the question of a folding screen is obviously ruled out. The possibility, however, of the screen passing into the scuttle by power operation has been considered, and in the design illustrated this refinement is possible. It was however decided to incorporate a fixed screen, as the cost of the suggested alternative despite its advantages, would not be justified.

This competitor's coloured drawing was carried out in light green for the upper panels and dark green for the wings, and whilst the general effect is good it lacks contrast by reason of the highlights not being sufficiently sharp.

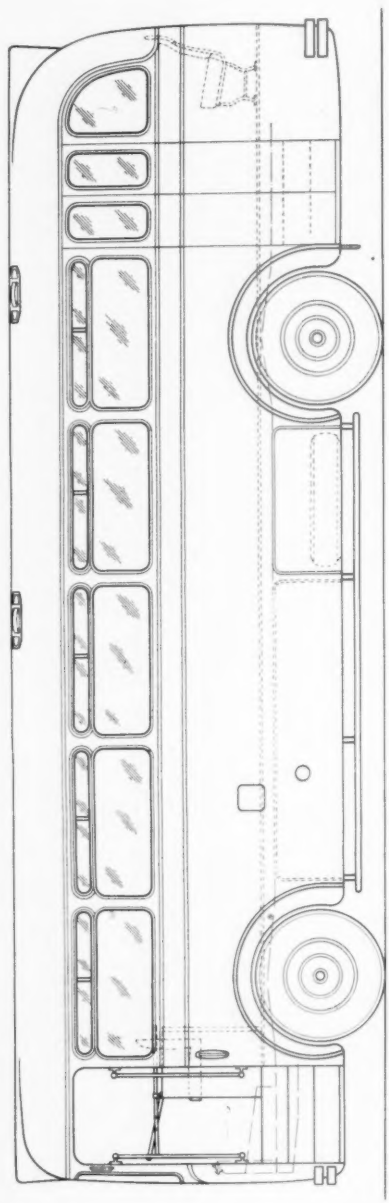
In this section the second prize of £15 was taken by D. S. Cleary, with a neat two-seater design which in addition to the general arrangement drawing, includes a small half-tone illustration, which was carried out in excellent style. The general arrangement drawing gave all details of the head mechanism and the comparison between this and the design securing first prize is mainly in the difference in boot capacity. A detachable panel is provided in the rear of the hood, and the hood when folded stands very slightly above the waist line.

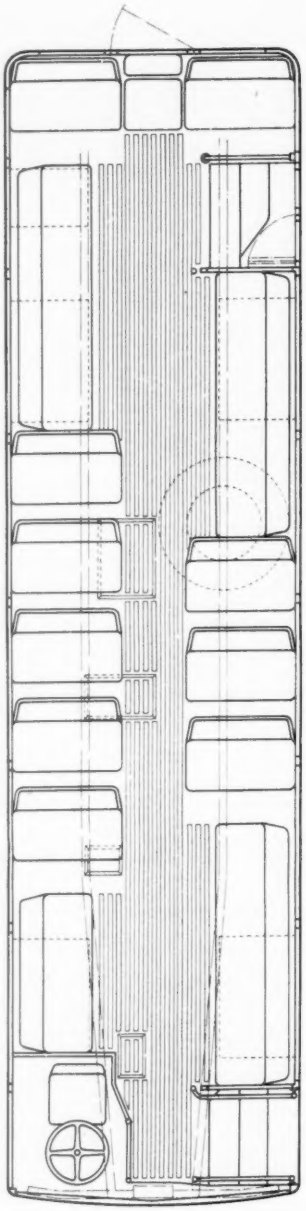
It is interesting to note that in designing the chassis within the specified dimensions, this competitor arranged his petrol tank across the chassis above the rear axle, the tank thus occupying what might otherwise be wasted space beneath the furled hood. Also, this arrangement enables full use to be made of the storage space within the boot, luggage being stowed on the floor above the centrally disposed spare wheel. At either side of the spare wheel there are compartments for tools and any other items of a similar nature. In addition to the storage space available above the spare wheel, there is room between the spare wheel and the boot lid for a specially shaped suitcase, and this is shown in the drawing. To assist in removing the spare wheel from the boot, a roller is arranged at the rear end of the boot floor.

The third prize was awarded jointly to I. H. Marshall and N. Morris, each of whom received £7 10s.

Competition No. 4

This competition called for a one-sixteenth scale general arrangement drawing of a full-fronted single-deck bus for city service work involving frequent stops. Overall dimensions of 30 ft long and 8 ft wide were specified, and the body had to be designed to suit a chassis with an underfloor engine. The method of construction was left to the competitor and the body had to comply in all respects with current Ministry of Transport regulations. The general arrangement drawing had to show the elevation, front, rear and plan views, and in addition a half cross-section was required, giving details of construction to a scale not exceeding 1½ in to the foot. In designing the body the competitors were asked to pay attention to the special needs of City service work, including the provision of maximum capacity for both seated and standing passengers, consistent with reasonable comfort, bearing in mind that rapid





GENERAL LAYOUT OF BUS DESIGN BY K. HUNT

loading and unloading at rush hour periods was likely to be encountered.

The first prize of £75 and the Company's medal was awarded to K. A. G. Hunt, who favoured a 39-passenger front entrance vehicle with the driver separated from the passenger compartment by a waist height partition behind his seat, and by hinged guard rails at the side. No door is used for the front entrance which has three steps with 8¼ in risers to reach floor height. To promote speedy unloading there is an exit door on the near side behind the rear wheel, and this has a double folding door operated by Peters mechanism. In the rear panel there is an emergency exit which is normally obstructed by the rear seat, but there is a tip-up section which is readily folded when required.

Above the fixed side windows there are Quicktho Fleximount window units which incorporate sliding glass, the same arrangement being repeated on the off-side. Three seating plans are shown, and in the arrangement giving accommodation for 39 passengers, there is on the off-side a longitudinal seat for three passengers immediately behind the driver, followed by five double seats arranged transversely. This is followed by a longitudinal seat for five passengers, commencing over the rear wheel arch, whilst across the rear panel of the bus there is a double seat each side with a tip-up seat between them. On the near side there is a longitudinal seat for five, immediately following the front entrance; then three transverse seats for two, and a further longitudinal seat for five. In addition to the 39 passengers thus accommodated, it is also possible for this body to carry 16 standing passengers.

Another seating plan with all the seats facing forwards except one single seat above the rear wheel arch, gives accommodation for 42 passengers seated and 16 standing passengers, whilst the third plan is similar to the first except that the near side seats are single instead of double, and the capacity is therefore 34 seated and 24 standing passengers.

This competitor favours all-metal construction and his sectional details give a very clear idea of the methods which he intends should be used. The deep bearer channels have 10 S.W.G. mild steel gussets for their connection to the pillars, which are timber filled to facilitate the attachment of the panel. Above the waist line 16 S.W.G. light alloy mounting plates 2⅝ in wide are used for mounting the Quicktho Fleximount window units, and these light alloy mounting plates are secured with countersunk-head wood screws and a cover plate with a Sheradized finish. Aluminium window finishers are used, and the pillars are in aluminium alloy channel.

In the underframe, the bearer channel consists of a lipped channel section in high grade carbon steel, and towards the upper face a stiffening gusset is spot welded in position. This gusset takes a wood fillet upon which the floor is mounted, and the overall dimensions of the bearer channel are 3¼ × 1¾ in.

In this class the second prize of £37 10s. and the Company's medal was taken by S. H. Anderson, whose 38-seater design had the entrance door just forward of the near side rear wheel, and giving 2 ft 5½ in clear entrance. The exit is at the front behind the wheel, and here again a door is fitted. These doors are power operated and are interconnected, whilst the arrangement includes a sensitive leading edge to automatically reverse the action should a person become trapped. The doors are controlled from the conductor's platform, adjacent to the entrance door, thus enabling a form of "pay as you enter" system of fare collection to be adopted. The emergency exit is towards the front on the off side, and to free the space adjacent to this exit, the first seat on the off side faces the rear, whilst the second seat faces the front.

This competitor favours a heating and ventilating system which admits air at either side of the destination and number boxes in the front roof panel. The intake for air to be passed to the heating system is on the off side, and the air passes through a Clayton heater above the driver's seat. Cool air is taken in on the near side and passes through a duct adjacent to the roof border panel, hit-and-miss grids admitting it to the body as desired.

In the construction of the body, an all-metal frame is used and a timber floor is specified. The exterior panels below the lower rubbing strip at the front and the rear of the vehicle are in steel, and all other panels are in aluminium. In the construction of the heating and ventilation ducts, insulation is obtained by the use of Fibreglass.

The third prize of £15 and the Company's medal was awarded to J. Fyfe, whilst the entry submitted by J. Grounds was highly commended, and he received a £5 award.

In competition No. 5 the subject was a mobile office as used by a travelling business executive, and competitors were required to submit an arrangement drawing to a scale of ¾ in to the foot, whilst constructional details to a scale not exceeding 1½ in to the foot were also required. The first prize was awarded jointly to J. Jenkins and E. G. Broadbent, each of whom received £56 5s. No second prize was awarded, but a third prize of £10 each was awarded to L. Longley and S. Jackson.

NEW OIL-CONTROL RING

PRODUCED by the manufacturers of the Cords cupped piston ring, this new ventilated ring is intended primarily, but not exclusively, for replacement service in worn cylinder bores. Named the Oilguard ring, it comprises a minimum of three elements. A flat lower ring and a cupped upper ring are spaced apart by a corrugated ring. Should extra width be required to suit an existing ring groove, one or more flat rings may be added.

As all rings exert radial pressure, no expander ring is required, and thus the necessity to deepen the ring groove in a piston will not usually arise. Similarly, the use of a cupped ring furnishes lateral pressure and obviates the need for extreme precision in the groove width and the overall ring thickness. By this means a production problem is overcome, for in this connection an interesting fact emerges. Swedish manufacturers can roll the strip steel from which the rings are produced to a tolerance of ±0·0005 in but British manufacturers demand a tolerance of ±0·002 in. The accumulation of tolerances in a laminated ring may be considerable and thus the cupped, laterally resilient ring makes possible the use of available British material without the risk of either ring-sticking or oil-pumping. (2015)

The Cords ventilated ring

Lincoln Weldirectory

THAT informative publication, the Lincoln Weldirectory, has now appeared in its 1952 edition. Larger than its predecessor, the material is conveniently and attractively arranged. Each of the firm's welding rods is dealt with on a separate page giving the properties, the recommended operational procedure, and an illustration of a typical example of work. Welding tools, equipment, shields, and protective clothing are also listed and described. Copies of the new edition are obtainable from the Lincoln Electric Co. Ltd., Welwyn Garden City, Herts. (2019)

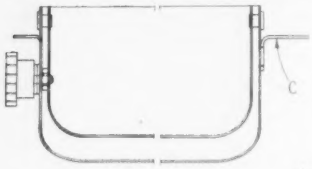
CURRENT PATENTS

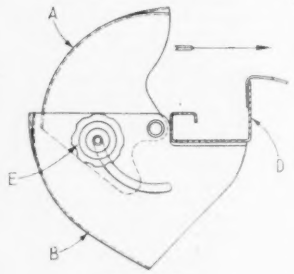
A Comprehensive Review of Recent Automobile Specifications

Vehicle ventilator

AN air intake ventilator for vehicles equipped with a sliding roof comprises a transversely mounted scoop which may be retracted to permit the sliding panel to be closed. The scoop or cowl *A*, in the form of a quadrant of a hollow cylinder with closed ends, is pivotally mounted in the end walls of a casing *B* having a width less than the width of the roof opening. Lateral lugs *C* on the end walls are secured to the underside of the front member *D* of the water-check frame.

With the scoop raised, as shown, air enters the vehicle interior and is directed by the casing forward and downward over the inner face of the windscreen. In the fully retracted position it lies entirely below the plane of the inner flange of the





No. 667418

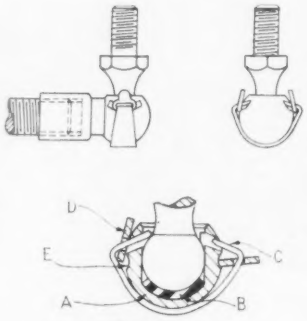
roof framing. A large clamp nut *E*, on a stud secured to the scoop and passing through an arcuate slot in the casing, allows the scoop to be frictionally locked in either extreme or any intermediate position. *Patent No.* 667418. *Weathershields Ltd. and A. S. Clay.*

Control linkage ball joint

TO minimize lost motion in the connections of remotely actuated gear control mechanisms, recourse is had to ball joints. Particularly intended for that duty, this joint has the advantage of being readily disconnected and recoupled. .

The ball stud of orthodox pattern is entered in the cylindrical bore of the socket *A* and seated on a disc *B* of oil-resistant rubber on the part-spherical bottom wall. A spring *C* encircles the socket and its ends extend through diametrically opposite slots near the mouth of the socket to engage the ball at the junction with its stem. The resilient disc *B* exerts pressure on the ball and forces the ends of the spring against the upper sides of the slots.

Cam members *D*, threaded over the



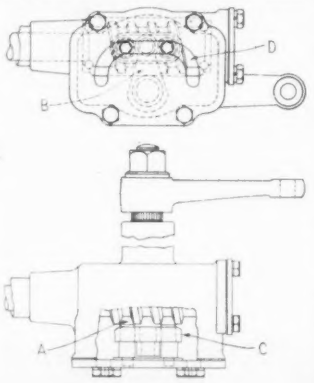
No. 667073

spring ends, are retained in the position shown on the left of the section when the joint is fully assembled. When cams *D* are turned outwardly, as shown on the right, they engage grooves *E* in the socket and retract the spring ends and allow the ball to be withdrawn. *Patent No.* 667073. *The Coventry Movement Co. Ltd., and T. E. Bolton.*

Steering gear

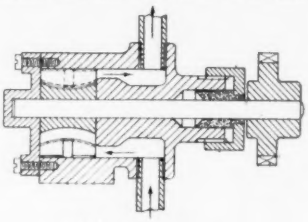
IN steering gears of the cam type employing a plurality of followers, some conflicting considerations may arise affecting the dimensions of the cam, the recession of the followers from the cam axis, the strength of the cam flanks and the mechanical advantage secured. This invention aims to avoid or reduce such practical limitations.

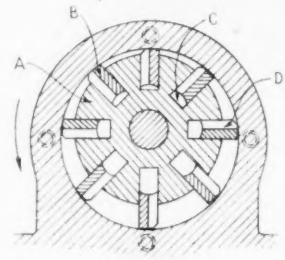
The arrangement of cam, rocker shaft and drop arm follows usual practice but the two followers *A* are not secured directly on the rocker arm *B*. Instead they are carried by a balance beam *C* pivotally mounted on the arm *B*. Of any known kind—fixed, rotatable, conical or curved—the followers have extended shanks that project on the opposite side of the beam and are engaged in a cam slot *D* formed in a plate bolted to the face of the housing. This control cam is symmetrical about a radial line joining the axes of the rocker shaft and the beam pivot when the rocker arm is in mid-position.



No. 667389

In the arrangement shown, the operative follower will move in a linear path, sensibly parallel to the axis of the cam, from mid-position to its extreme position. The cam can be straight cut with either a constant or varying pitch, recession of the follower from the axis of the cam is avoided, and the strength of the cam flanks can be maintained. Apart from any change of pitch, a change of advantage is provided automatically as the effective radial distance between follower and rocker shaft axis increases as the follower





No. 667140

moves from mid-position. Conversely, there is an increase in sensitivity as the follower approaches mid-position. *Patent No.* 667389. *George Kent Ltd. and L. W. Jukes.*

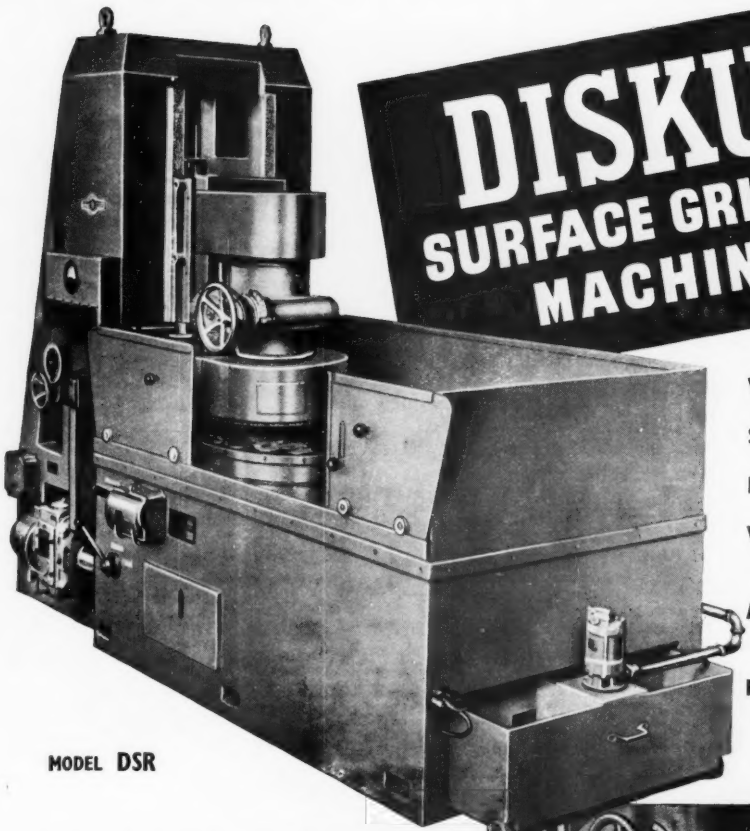
Vane-type oil pump

IT is suggested that in pumps of this type the use of springs to support the vanes is unsatisfactory. This design requires no springs and is claimed to be less costly to produce than a gear pump.

The cylindrical drum *A*, mounted eccentrically in the pump body bore in the usual manner, is machined with eight radial slots having an arcuate base. Vanes *B*, of similar shape, are furnished with two communicating grooves, *C* extending along the entire length of the base, and *D* across the front face. The leading working edge of the vane is chamfered.

First by inertia and then by pressure as the drum is rotated, oil is conducted to the space between the vane and the bottom of the slot and constrains the vane to bear against the casing bore. Groove *C* also serves to reduce friction by allowing an easy discharge of oil from below the vane as it approaches top centre. *Patent No.* 667140. *H. C. G. Vincent.*

DISKUS
SURFACE GRINDING MACHINES



VERTICAL SPINDLE

SEGMENTED WHEELS

LARGE STOCK REMOVAL

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AUTOMATIC DOWN FEED AND CUT OUT

RUN OUT TABLE FACILITATING LOADING

MODEL DSR

These robust yet precision-built machines known for their performance for heavy stock removal are a further development of the famous Diskus welded cell type construction and combine rigidity with great precision. The down feed is obtained through a hydraulic plunger operating the worm type quill. All controls are centralised. Hydraulic run-out table controlled by single lever.

Illustration above shows a close up of the table. These machines are suitable for grinding either a large number of small components simultaneously or one or two work pieces individually.

International Machine Tool Exhibition London 1952. Olympia, Sept. 17—Oct. 4

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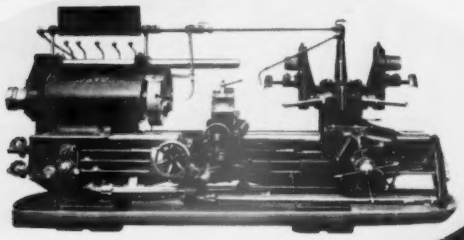
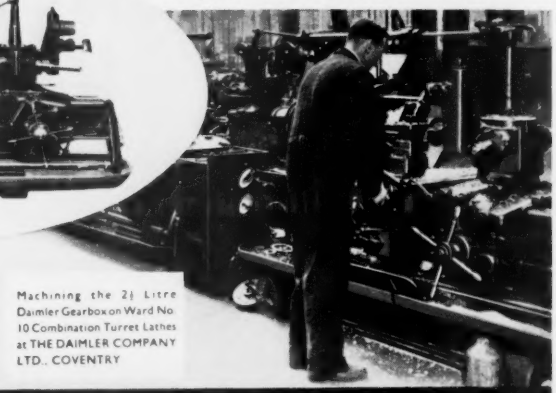
Ward machines are designed and built to get the best out of tungsten carbide, their metal removing capacity being limited only by the cutting tools used





Machining the 2½ Litre Daimler Gearbox on Ward No. 10 Combination Turret Lathes at THE DAIMLER COMPANY LTD., COVENTRY

OUR FULL RANGE INCLUDES MACHINES HAVING CAPACITIES FROM ⅛ IN. DIA. BAR UP TO COMPONENTS REQUIRING A SWING OF 35 INS. OVER THE BED COVERS

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High pressure investigation

Illustration shows Newton Victor Raymax 250 kV. Industrial X-ray Unit mounted on mobile crane, in use for radiography of circumferential weld in large pressure vessel. Reproduced by courtesy of Messrs. Newton Victor Limited.

Appearances can be deceptive, but it takes more than a smooth exterior to satisfy modern methods of inspection. Such is the case with welded pressure vessels, where radiographic examination of every inch of the seams has become an essential part of the manufacturing routine. Here, as in all branches of industrial radiography, ILFORD Industrial X-ray films satisfy the most stringent requirements and it is not surprising to find that all the exposures in the case illustrated were made on ILFORD Industrial X-ray Film Type B.

▶ ILFORD INDUSTRIAL X-RAY FILM TYPE A
A general-purpose film whose very high speed, exceptional latitude and good contrast when used with calcium tungstate screens make it particularly suitable for the examination of ferrous welds and heavy castings whether with X-rays or gamma rays.

▶ ILFORD INDUSTRIAL X-RAY FILM TYPE B
A fast film designed for direct exposure to X-rays or for use with lead screens. Recommended for the radiography of a wide range of castings and welds in light alloy or steel where the aim is the detection of fine detail with economical exposure times.

▶ ILFORD INDUSTRIAL X-RAY FILM TYPE C
A special high-contrast, direct-exposure film of medium speed and extremely fine grain, specifically intended for the radiography of magnesium and aluminium castings where very fine detail must be recorded, and for the examination of all materials having a low X-ray absorption coefficient.

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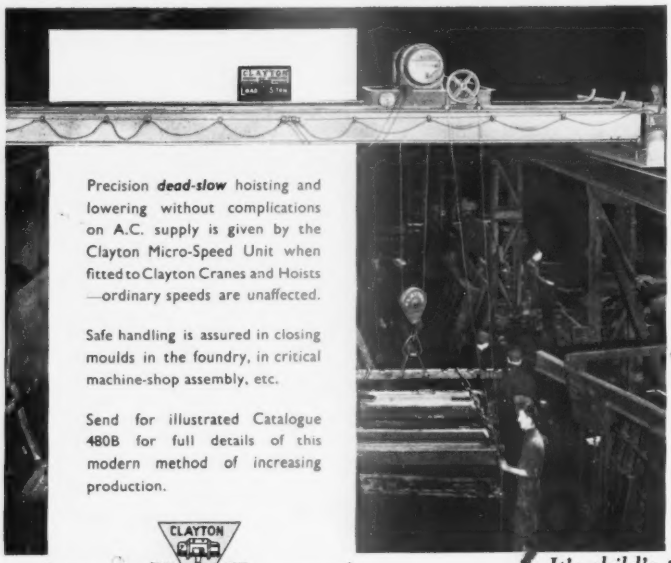

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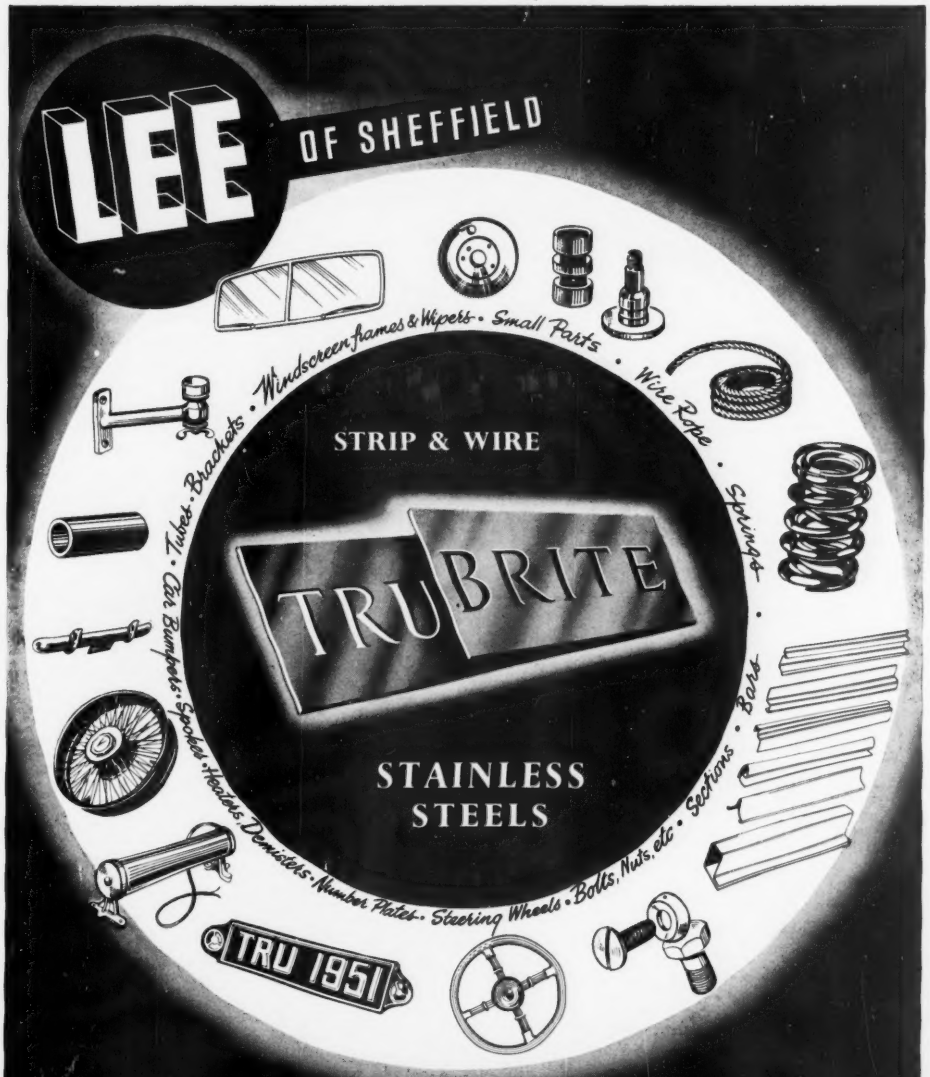

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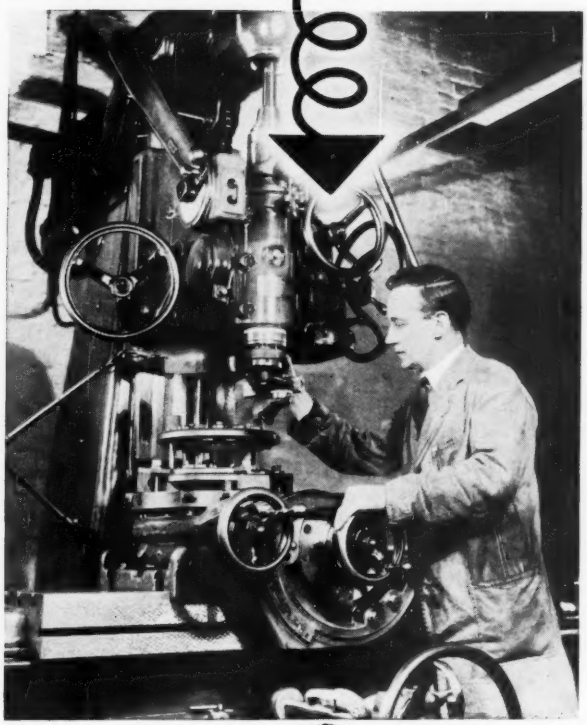

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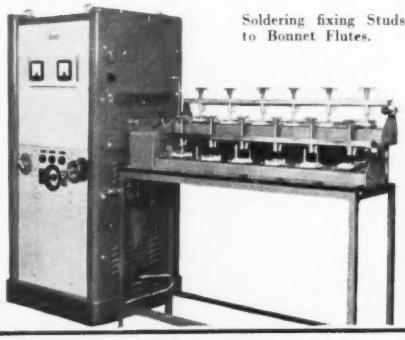

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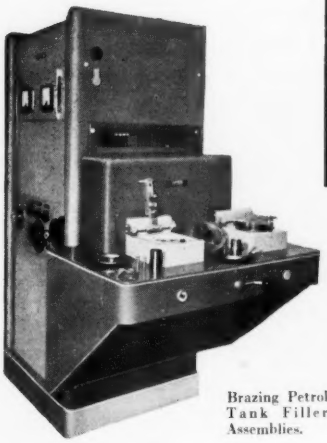

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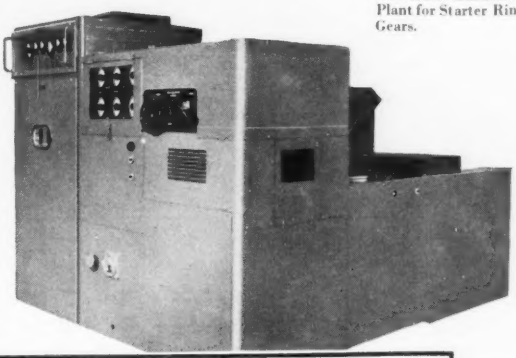

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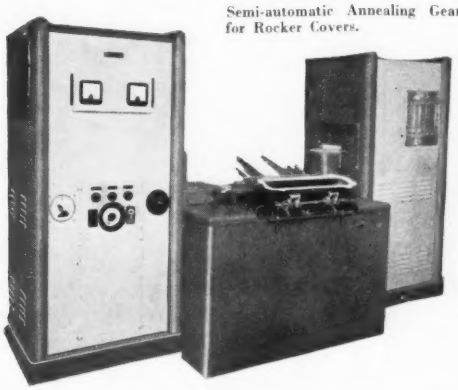

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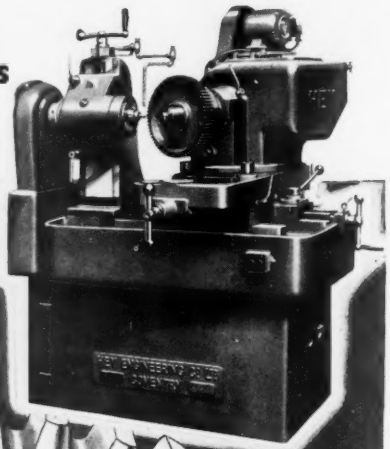

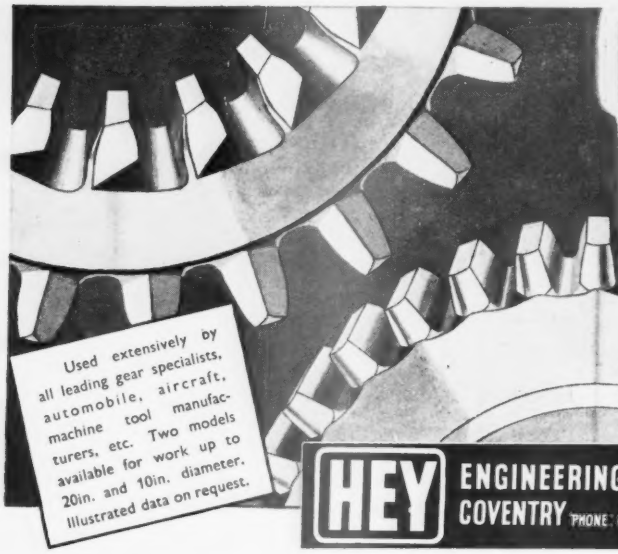

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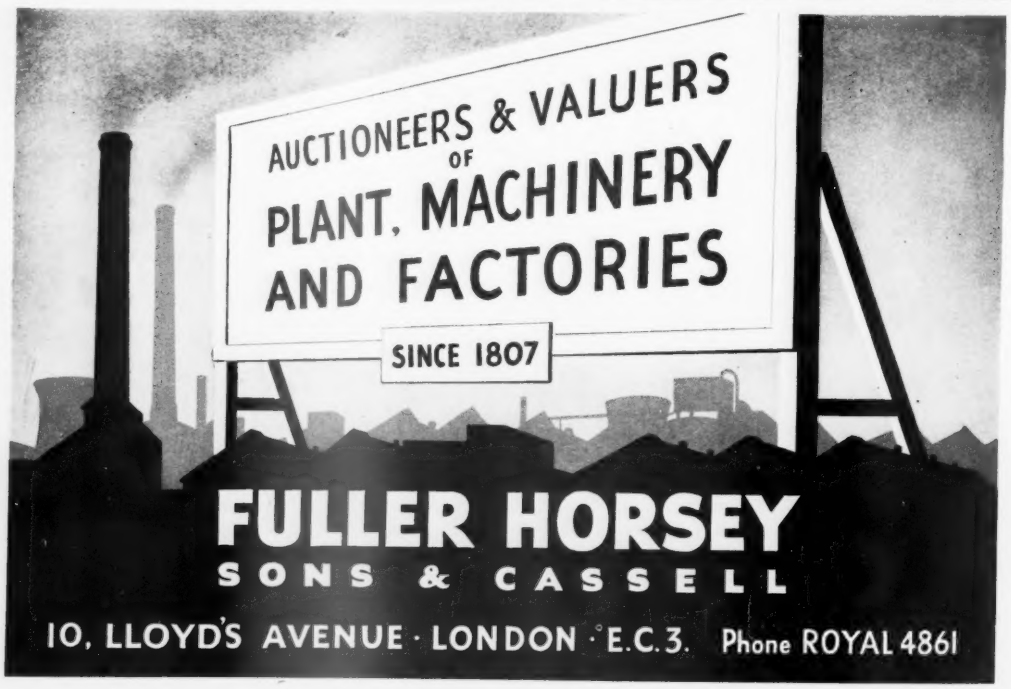

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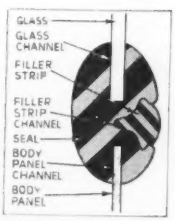

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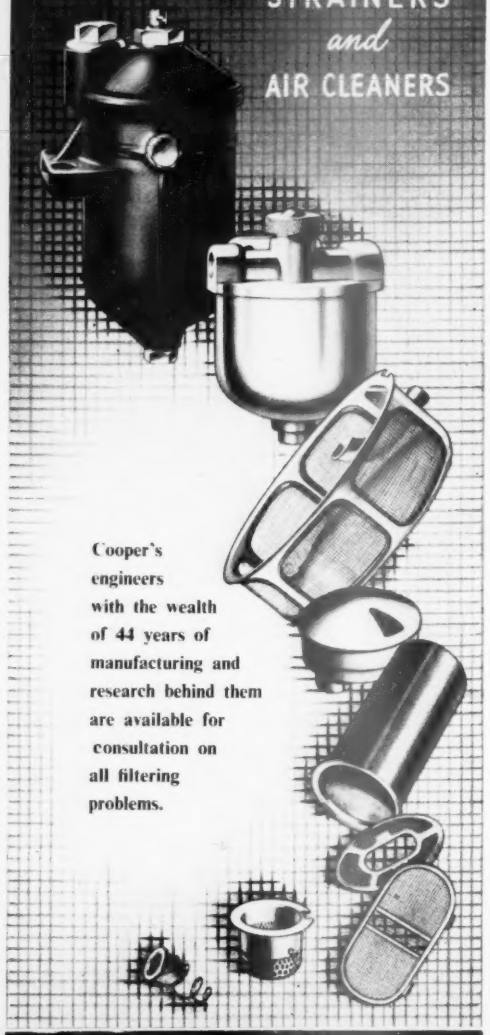

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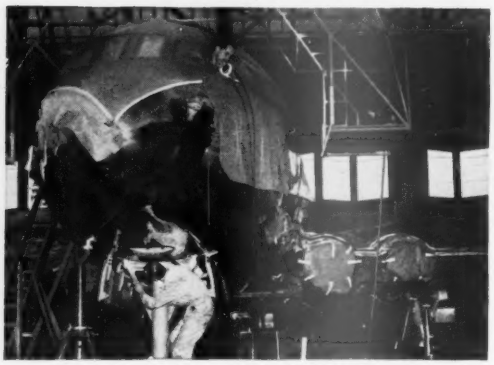

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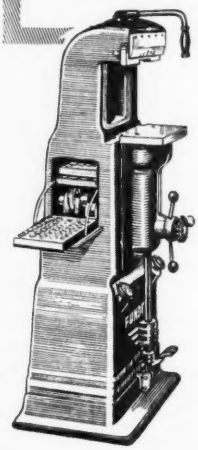

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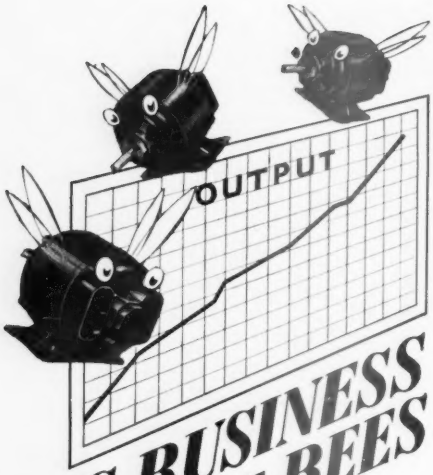

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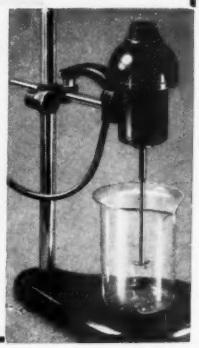

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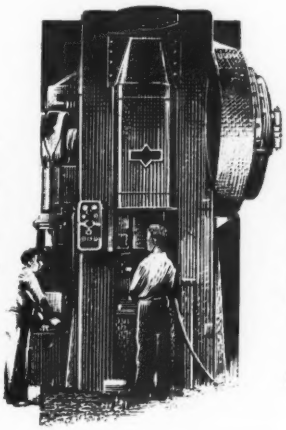

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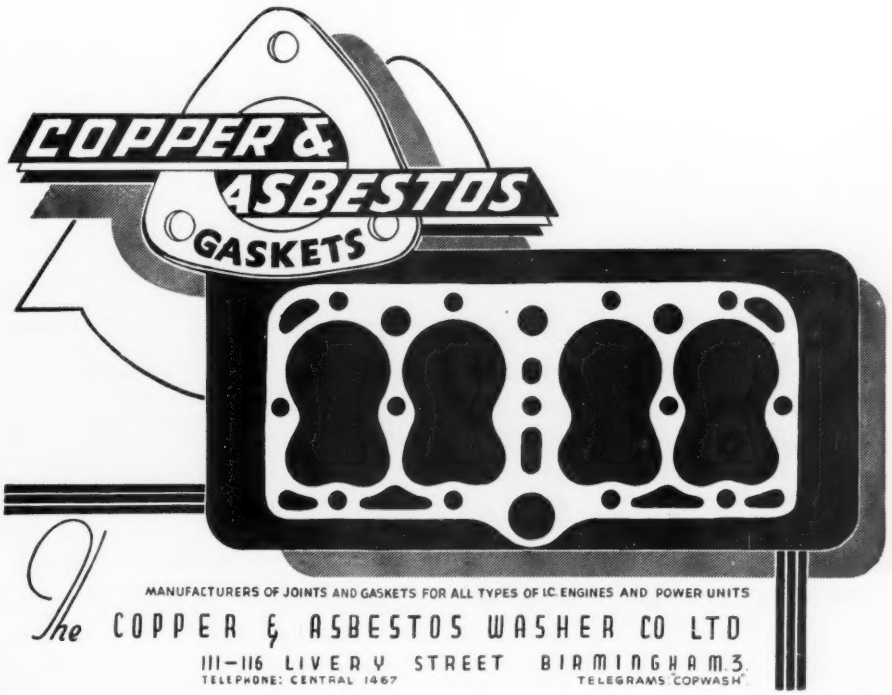

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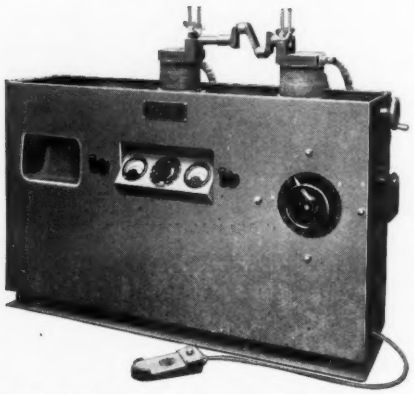

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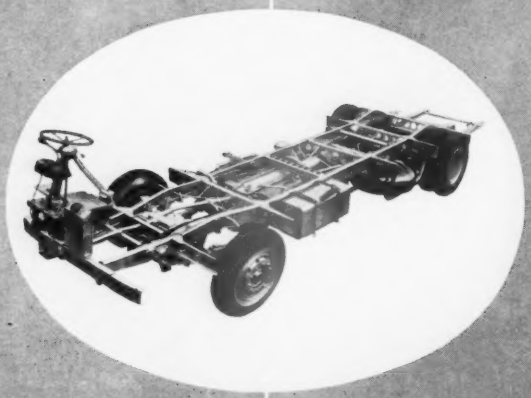

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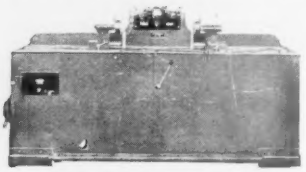

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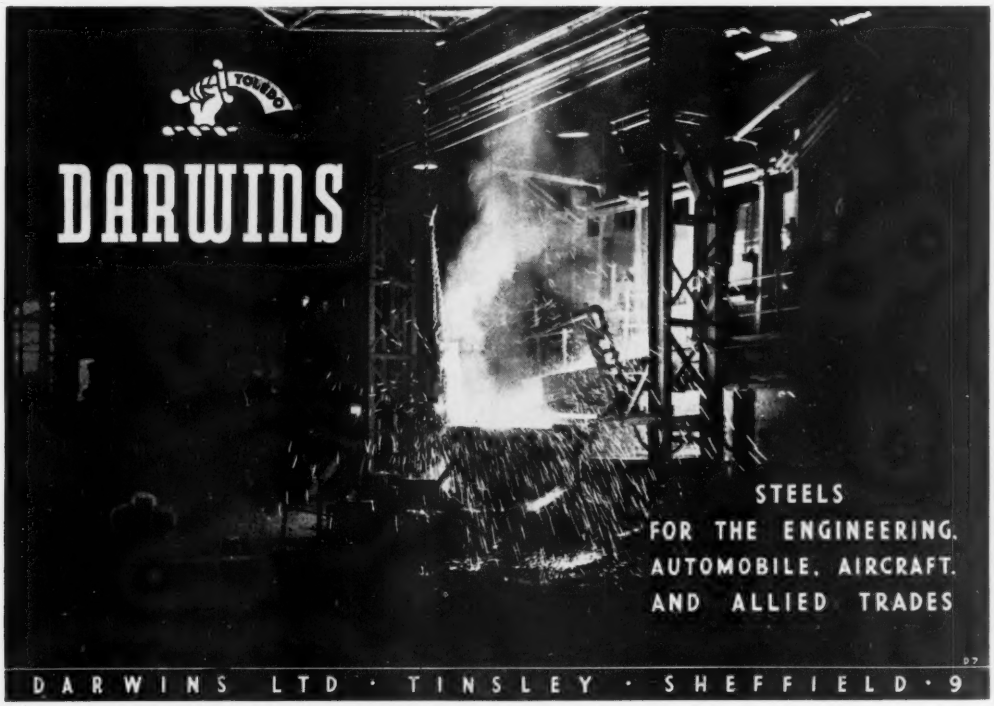

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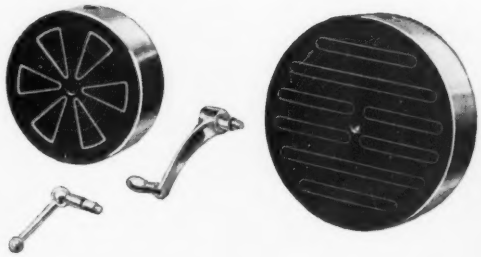

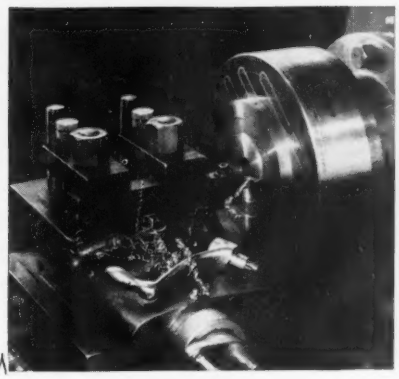

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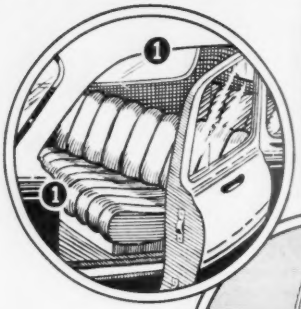

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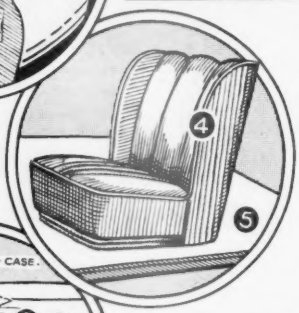

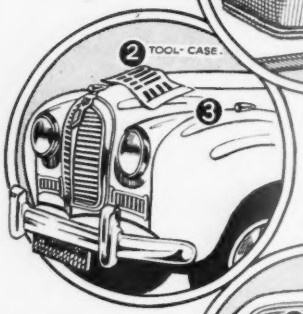

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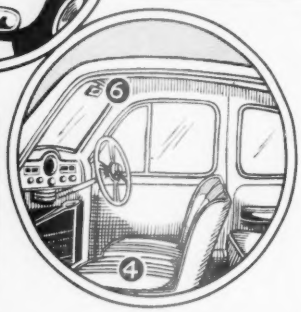

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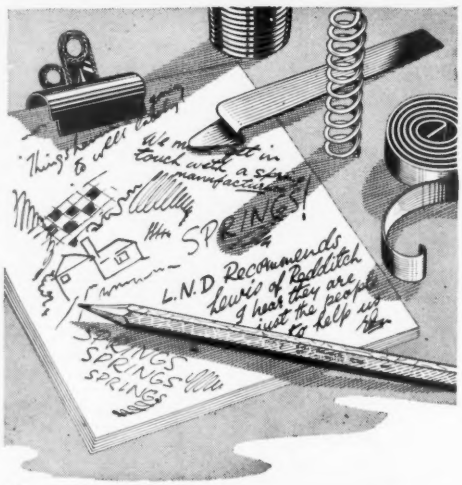

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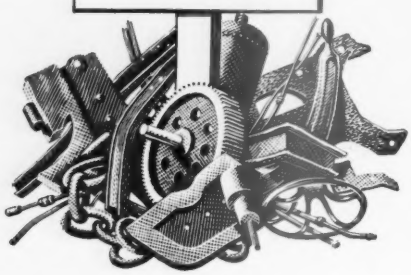

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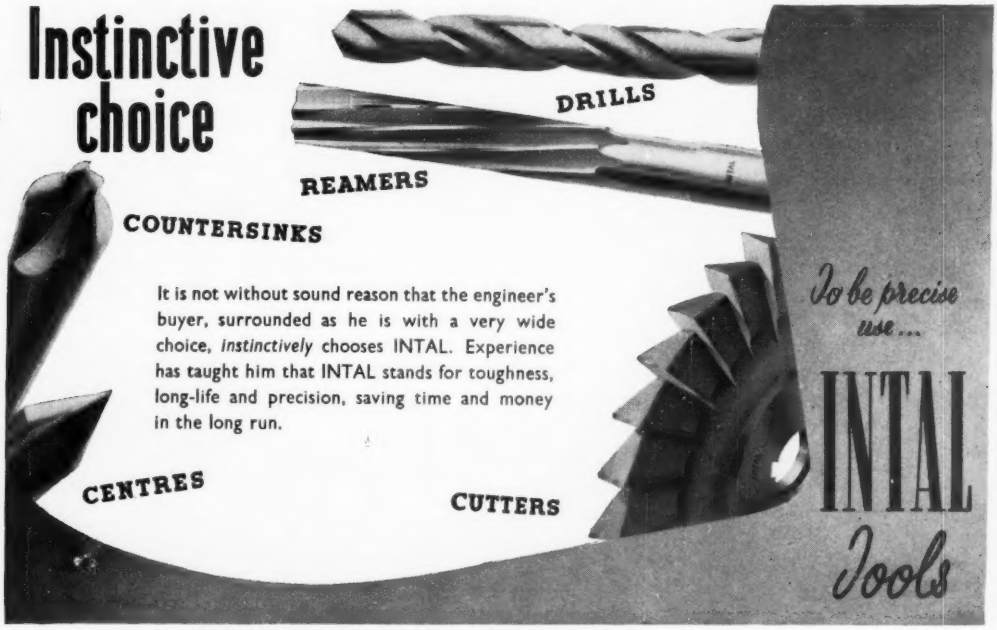

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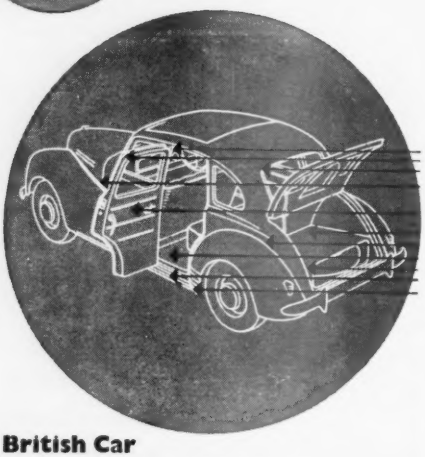

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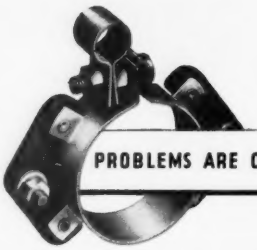

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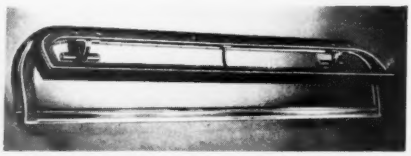

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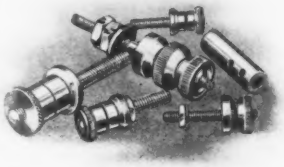

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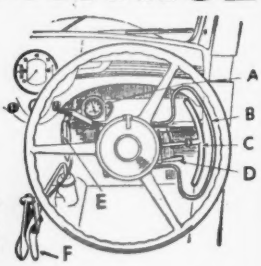

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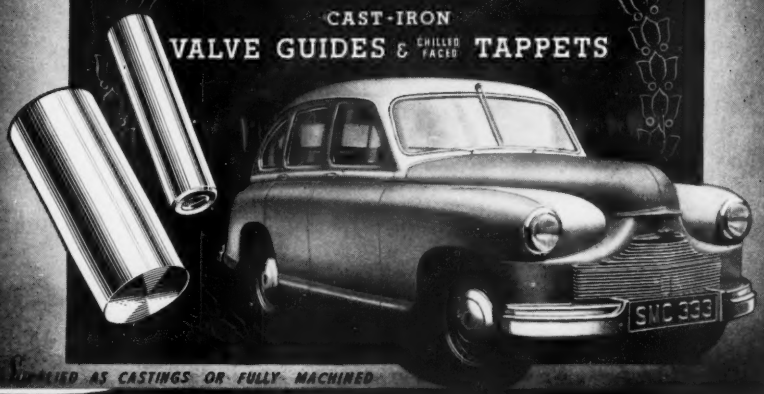

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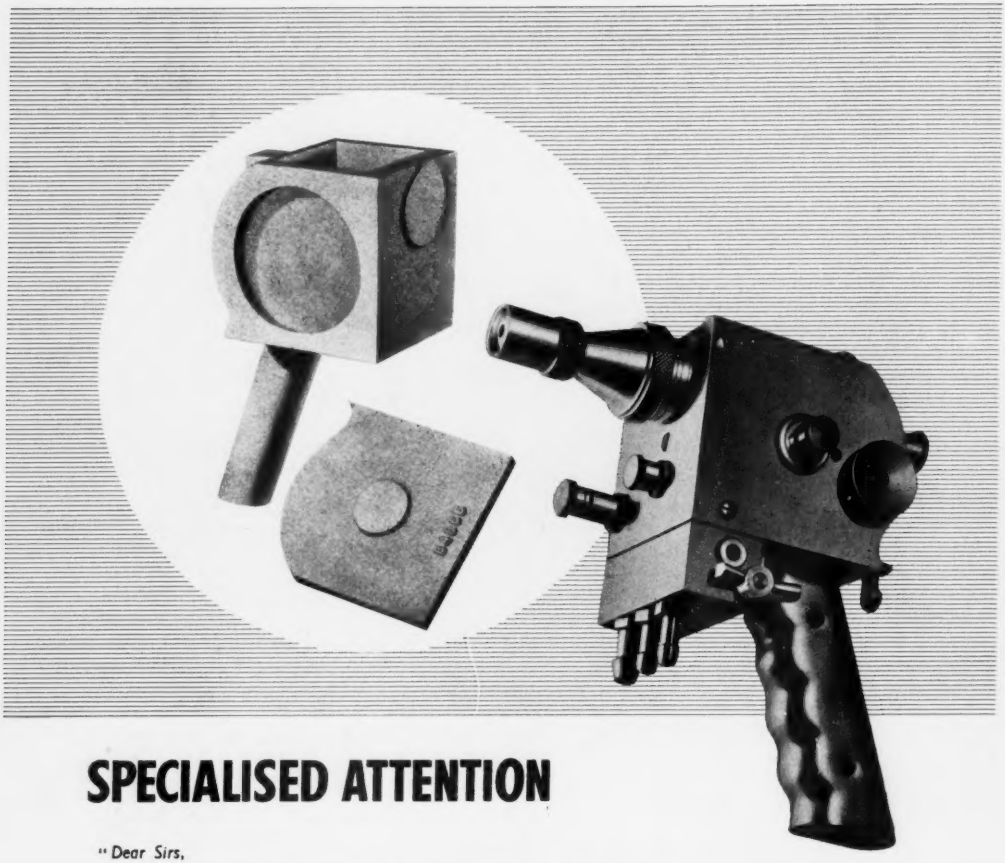

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